

THE
SURGICAL CLINICS
OF
NORTH AMERICA

JUNE, 1926

VOLUME 6—NUMBER 3

LAHEY CLINIC NUMBER

New England Deaconess and New England Baptist Hospitals,
Boston Mass

PHILADELPHIA AND LONDON

W. B. SAUNDERS COMPANY

COPYRIGHT 1926 W. B. SAUNDERS COMPANY ALL RIGHTS RESERVED
PUBLISHED BI-MONTHLY (SIX NUMBERS A YEAR) BY W. B. SAUNDERS COMPANY, WEST WASHINGTON
SQUARE PHILADELPHIA

MADE IN U. S. A.

CONTRIBUTORS TO THIS NUMBER

FRANK H LAHEY M D Surgery
HOWARD M CLUTE, M D , Surgery
ROBERT L MASON M D , Surgery
BURTON E HAMILTON, M D , Cardiology
LINCOLN F SISE M D Anesthesia
D CROSBY GREENE M D , Laryngology
SARA M JORDAN, M D , Gastrology
RICHARD B CATTELL, M D , Surgery

CONTENTS

Howard M. Clute	PAGE
SUBMAXILLARY GLAND CYST	579
Howard M. Clute and Robert L. Mason	
MEDICAL MANAGEMENT OF PATIENTS BEFORE OPERATION FOR HYPERTHYROIDISM	583
Frank H. Lahey	
REMOVAL OF THE CERVIX IN HYSTERECTOMY FOR BENIGN LESIONS	593
Richard B. Cattell	
THE EFFECT OF IODINE ON THE PATHOLOGY OF EXOPHTHALMIC GOITER	597
Frank H. Lahey	
MANAGEMENT OF TOXIC GOITER	603
D. Crosby Greene	
ESOPHAGEAL CASES	611
Burton E. Hamilton	
THE CHRONIC CARDIAC AS A SURGICAL RISK	621
Burton E. Hamilton	
CONGESTIVE HEART FAILURE AND ANGINA PECTORIS IN SURGICAL PATIENTS	637
Frank H. Lahey	
THE TREATMENT OF EMBOLI IN THE PERIPHERAL VESSELS	651
Frank H. Lahey	
MODERN CONCEPTIONS AND MANAGEMENT OF BILIARY TRACT DISEASE	667
Frank H. Lahey	
COLECYSTECTOMY	6 9
Howard M. Clute	
HYPERTHYROIDISM PERSISTING AFTER THYROIDECTOMY. THE NECESSITY FOR POST- OPERATIVE EXAMINATIONS IN TOXIC GOITERS	691
Frank H. Lahey	
THE SCHEME OF MANAGEMENT OF GASTRIC AND DUODENAL ULCER IN THIS CLINIC	695
Lincoln F. Sise	
ETHYLENE. USES AND PRECAUTIONS	703
Robert L. Mason	
SOME PHYSIOLOGIC ASPECTS OF POSTOPERATIVE TREATMENT	711
Lincoln F. Sise	
SPINAL ANESTHESIA	723
Robert L. Mason	
MASSIVE ATELECTASIS	739
Sara M. Jordan and Frank H. Lahey	
DIVERTICULA OF THE ALIMENTARY TRACT	747
Sara M. Jordan	
END RESULTS—CLINICAL, CHEMICAL AND MECHANICAL—IN TWELVE PYLORECTOMIES	767
Howard M. Clute	
SUPRARENIC INFECTION AFTER APPENDICITIS	775
Howard M. Clute	
CONGENITAL DEFECTS OF THE KIDNEY	783

THE SURGICAL CLINICS OF NORTH AMERICA

Volume 6

Number 3

SUBMAXILLARY GLAND CYST

HOWARD M. CLUTE

Cyst formation in the submaxillary gland may occur with any obstruction of Wharton's duct. The most frequent cause is a calculus in the duct which prevents, either completely or partially, the discharge of saliva from the gland. Other causes of obstruction of Wharton's duct which have been recorded are foreign bodies, such as a piece of grain, and chronic inflammation arising in the submaxillary gland or in nearby dental structures and affecting the duct. Very rarely a malignant tumor of the jaw or tongue may occlude the duct. Undoubtedly calculus occurs more commonly in the submaxillary gland and its duct than in any other salivary gland and presumably a calculus in Wharton's duct will most frequently be found as the cause of the obstruction.

A cyst of the submaxillary gland is commonly called a submaxillary ranula. This may be entirely above the mylohyoid muscle and cause a prominent tumor on the floor of the mouth at one side of and below the tongue. In old cases however, the tumor tends to push down through the mylohyoid muscle and present itself beneath the skin in the submaxillary triangle. In early cases submaxillary ranula may be excised through the mouth, but in later cases external operation with excision of cyst and gland is usually necessary.

Although we have had several patients with submaxillary calculi we have not previously seen any evidence of obstruction to the duct sufficient to produce the formation of a cyst. In our

experience patients with submaxillary calculi seek help because of the acute complications which arise. These are, first, the "salivary colic" so called, which occurs with a sudden complete obstruction to the duct during the salivation that accompanies a meal. The second common complication of salivary calculus is the occurrence of an acute infection in the duct or gland in which it lies. The history of the patient here reported is consistent with



Fig. 211 —Part of the submaxillary cyst showing through fascia after the platysma muscle was raised

recurrent obstruction of Wharton's duct by a calculus, with the final formation of a stricture in some one of the ducts of the gland and resultant cyst formation.

Case History.—The patient was a woman aged thirty-four, whose chief complaint was of a swelling in the right submental and submaxillary regions. Seven years ago she first noted a soft mass the size of a hickory nut beneath the ramus of the right jaw. This mass grew in size for several days and then discharged into

the mouth. No pain occurred. The tumor repeatedly swelled and discharged into the mouth at intervals for a year. Five years ago the swelling again occurred and extended along the ramus of the jaw—anteriorly to the submental region and posteriorly to the parotid region. This fulness has persisted with little if any variation during the last five years

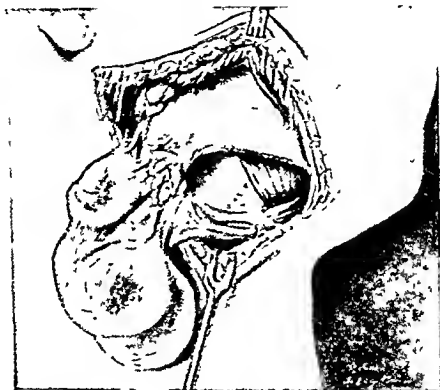


Fig. 212—Final stage in the removal of submaxillary gland cyst and the remaining portion of the gland. The cyst had extended nearly to the symphysis of the jaw lying largely beneath the ramus. Posteriorly it extended to the floor of the mouth under the angle of the jaw and externally to the region of the parotid gland.

On examination a definite diffuse swelling was observed behind and below the angle of the jaw on the right. The swelling was soft and felt cystic. There did not seem to be a tense distention of any sac. By manipulation it was evident that the swelling possessed portions which extended anteriorly beneath the ramus of the jaw to the submental region and superiorly in front of the

ear into the region of the parotid gland. With a finger in the mouth the tumor could be palpated beneath the tongue on the right side.

Operation was performed without particular incident. An incision was made below and parallel to the ramus of the jaw and the cyst carefully dissected from contiguous structures. The wall of the cyst was extremely thin and had extended along the jaw on the inferior buccal surface to the midline anteriorly. Posteriorly it extended upward into the parotid region. But very little submaxillary gland tissue was left. All of the outer wall of the cyst was readily removed with the remains of the submaxillary gland. Some of the cyst wall lying deep in the floor of the mouth was not dissected.

Recovery from the operation was uneventful, the wound healing being rapid and complete. No salivary leakage occurred after operation.

Pathologic examination of the specimen showed cystic dilatation of a large salivary gland duct which was also involved in a periductal inflammatory process. Areas of normal salivary gland tissue were also present.

MEDICAL MANAGEMENT OF PATIENTS BEFORE OPERATION FOR HYPERTHYROIDISM

HOWARD M. CLUTE AND ROBERT L. MASON

THE symptoms of hyperthyroidism can in part be alleviated and the patient rendered a better operative risk by the judicious employment and combination of two methods of treatment *one*, the use of measures designed to combat the high basal metabolic rate and *two* the use of iodine the only drug of demonstrated merit which will lower the metabolic rate.

Of all the measures designed to combat the high metabolic rate the most generally useful is rest. The regular drop of twenty to forty points in metabolic rate that occurs repeatedly if not constantly with rest in bed, can with fairness be laid to a decrease of the metabolic burden from decreased muscular and mental activity. To obtain the best results from rest alone particular attention must be given each individual. Exophthalmic goiter patients do not adjust themselves readily to rest in bed and they must be personally instructed and persuaded to control their ceaseless wasteful movements and excited conversation. Isolation of severely toxic patients and all other indirect aids to rest must often be elaborated to a marked degree. Visitors must be limited or carefully selected. At times even letters must be withheld because of the depression or excitement they cause.

Second only to rest in bed in the preoperative treatment of hyperthyroidism is careful attention to the diet of the patient. Thyrotoxic patients almost invariably show striking under nutrition when they present themselves for treatment. Their body weight averages 15 to 25 per cent below the normal standards. The loss of weight may be extreme if the patient has been carrying on an occupation requiring moderate or heavy exertion. This marked loss of weight is due to an inability adequately to

meet the high caloric requirement of their increased rate of metabolism. The food intake being insufficient, the body tissues are consumed to meet the deficit. It has been conservatively estimated that a man with a metabolic rate of $+50$, doing a moderate amount of muscular work, requires 6000 calories daily to maintain his weight. Such a requirement demands an intake of an enormous amount of food, and in spite of the huge appetites nearly all of these patients possess they are unable to consume adequate amounts of food. This feature is of great importance in the preparation of the thyrotoxic patient for operation and also during the postoperative period. We have found it necessary to furnish from 3000 to 4000 and even 5000 calories daily to prevent weight loss. Considerable ingenuity is required on the part of the nurse to furnish a diet which contains the required caloric content, but which is not so bulky as to stuff the patient nor concentrated to such an extent that gastric upsets are induced. The patients' favorite foods should be discovered and every effort made to make the food desirable. Carbohydrates should be given in plentiful amounts. The carbohydrate metabolism in hyperthyroidism has long been a subject of inquiry. A few cases show a moderate hypoglycemia during their preoperative preparation and during the immediate postoperative period. Others, while showing no hyperglycemia, frequently have glycosuria. Excessive oxidation of sugar has been shown to take place in hyperthyroidism. From data derived from a consideration of the total respiratory exchange and the respiratory quotient, twice the normal amount of carbohydrate has been shown to be oxidized in a given period in hyperthyroidism. Animal experiments have shown a depletion of glycogen in the liver in cases of induced hyperthyroidism. Since glucose is oxidized at a rate greater than normal in these patients and there are indications that there is a depletion of the carbohydrate reserve the necessity of carbohydrate is clear.

Thyrotoxic patients frequently show evidences of marked dehydration when they present themselves for treatment. Many are mildly acidotic. The heat generated by the increased energy exchange within the body must be removed by evaporation, and

for this purpose an increased supply of water is essential if dehydration is to be prevented. In our experience, fluids should be forced to an intake of at least 3000 c c daily. The fluid intake need not, of course, be confined to water. Ginger ale, grape juice, etc. are doubly useful in that carbohydrates are also furnished. Tea and coffee we avoid because of their stimulating action.

In patients with intense toxicity, whose weight loss has been excessive, gastro intestinal crises manifested by vomiting and diarrhea frequently occur. These patients are dehydrated, and it is obvious that considerable tissue breakdown has occurred to meet the demands of their high metabolism. Acidosis may be present or impending. The indication here for fluids and glucose is imperative and the improvement following the intravenous administration of 500 c c of a 10 per cent glucose solution is usually marked.

The glucose should be given in a 10 per cent solution and the flow so arranged that at least an hour's time is consumed in the introduction of 500 c c. If introduced at a more rapid rate a considerable portion of the glucose is apt to be excreted in the urine. Blood sugar determinations taken two hours after such an administration of glucose show but a slight degree of hyperglycemia. If the patient has, during previous observation, shown glycosuria, the blood sugar level following intravenous glucose is often sufficiently high to produce a marked glycosuria. In these patients small doses of insulin may be used to advantage in accelerating the utilization of the sugar. We do not recommend the routine use of insulin in conjunction with the glucose since in hyperthyroidism no deficiency in carbohydrate utilization exists, and if the glucose is given at a sufficiently slow rate most of the sugar is utilized satisfactorily. Theoretically, the use of insulin is contraindicated in hyperthyroidism. Insulin in the non diabetic has been shown to reduce the glycogen content of the liver. As before stated, the glycogen content in hyperthyroidism is at a low level, and further depletion by insulin would appear unwise.

We have given iodine in thyroid storms in large doses directly and parietyally according to circumstances. We believe it is often

meet the high caloric requirement of their increased rate of metabolism. The food intake being insufficient the body tissues are consumed to meet the deficit. It has been conservatively estimated that a man with a metabolic rate of $+50$ doing a moderate amount of muscular work requires 6000 calories daily to maintain his weight. Such a requirement demands an intake of an enormous amount of food and in spite of the huge appetites nearly all of these patients possess they are unable to consume adequate amounts of food. This feature is of great importance in the preparation of the thyrotoxic patient for operation and also during the postoperative period. We have found it necessary to furnish from 3000 to 4000 and even 5000 calories daily to prevent weight loss. Considerable ingenuity is required on the part of the nurse to furnish a diet which contains the required caloric content but which is not so bulky as to stuff the patient nor concentrated to such an extent that gastric upsets are induced. The patients' favorite foods should be discovered and every effort made to make the food desirable. Carbohydrates should be given in plentiful amounts. The carbohydrate metabolism in hyperthyroidism has long been a subject of inquiry. A few cases show a moderate hypoglycemia during their preoperative preparation and during the immediate postoperative period. Others while showing no hyperglycemia frequently have glycosuria. Excessive oxidation of sugar has been shown to take place in hyperthyroidism. From data derived from a consideration of the total respiratory exchange and the respiratory quotient twice the normal amount of carbohydrate has been shown to be oxidized in a given period in hyperthyroidism. Animal experiments have shown a depletion of glycogen in the liver in cases of induced hyperthyroidism. Since glucose is oxidized at a rate greater than normal in these patients and there are indications that there is a depletion of the carbohydrate reserve the necessity of carbohydrate is clear.

Thyrotoxic patients frequently show evidences of marked dehydration when they present themselves for treatment. Many are mildly acidotic. The heat generated by the increased energy exchange within the body must be removed by evaporation and

case of exophthalmic goiter and we have usually been surprised to find adenomata present in addition to simple hyperplasia. In regard to them we feel that clinically they cannot be separated from true cases of exophthalmic goiter and that they should be classed in that group in a discussion of this sort.

The actual method by which the patient with primary hyperthyroidism obtains iodine is of secondary importance. We commonly give compound solution of iodine in 10-minim doses diluted in water three times a day after meals. If this method is inadvisable, the iodine may be given in 5-minim doses by mouth at shorter intervals or by rectum well diluted in water. In emergencies we have given it intravenously and subpectorally in doses of 50 minims of Lugol's solution to 1000 c.c. of normal saline. We have seen no disturbance from this in the few cases in which we have felt compelled to give the drug in this manner. When a thyroid storm is anticipated we force iodine by every available route in large doses up to 100 minims of Lugol's solution in twenty-four hours, and we continue giving large doses for one or two days after the storm has passed.

Dr. R. B. Cattell, in this clinic, has studied the microscopic changes produced in the hyperplastic thyroid gland by iodine feeding, and he has found these to be both typical and pronounced. In hyperplasia the papillary projections into the acini of the gland with their highly active columnar epithelium are replaced or markedly altered. The acini become distended with colloid material and the epithelium is made up of cells much lower and apparently less active. It has long been known that the iodine content of the thyroid gland diminished in direct proportion to the degree of hyperplasia present. What the reason for this extraordinary change in the structure of the gland after iodine therapy may be is not known. It occurred, however, in 88 per cent. of the cases of true hyperplasia that were given iodine.

The improvement in clinical symptoms and in basal metabolic rate in cases with thyroid gland hyperplasia receiving iodine is generally very marked. The average drop in basal rate after eight days of rest in bed and iodine feeding is thirty points

Apparently the maximum iodine effect is obtained within eight to twelve days of its first administration. This then is the optimum time for operation. From 7 to 10 per cent of our cases, however fail to show any marked improvement of basal rate. These cases may nevertheless show a marked improvement of their nervous symptoms in spite of this fact. We have found as Plummer has said that in most cases the nervous symptoms of exophthalmic goiter are particularly affected by iodine. The tremor is less, the exophthalmos diminishes and the subjective feeling of nervousness disappears. In a few cases all the symptoms and signs of the disease have completely disappeared. It is our firm belief however that iodine alone will not cure exophthalmic goiter. We are constantly seeing patients who have been carried along on iodine therapy for months and even years in the hope that the disease would be permanently checked. In no case that we have seen has this occurred. Toxicity has not been obtained until a part of the thyroid gland has been removed. Furthermore when iodine administration is carried far beyond the early period of maximum effect its great value in reducing the operative risk is lost.

Not only is the use of iodine alone insufficient to produce a cure in cases of exophthalmic goiter but also is it frequently misleading in the degree of apparent improvement that it has brought about. In our early experience we were misled in certain cases by the marked drop in basal rate and the great clinical change into doing a larger operation than the true condition of the patient warranted. We now believe that a patient who is dangerously ill on admission to the hospital does not become a good surgical risk in a few days no matter how much iodine he may receive or how great the apparent improvement. Potentially he is still a serious operative risk and must be so considered.

The use of iodine has certain very definite limitations in our experience. We have had patients enter a thyroid storm after several weeks of constant iodine medication and go on to death in spite of large amounts of iodine fluids rest and morphine and in the absence of any operative procedure. Postoperative storms have occurred in patients thoroughly prepared for opera-

tion with iodine. However, while there are certain very definite limitations to the results iodine will produce in the treatment of exophthalmic goiter, it is nevertheless the greatest single agent that we possess for preparing these patients for surgery. It is very important that its effects be cautiously accepted and carefully interpreted in the light of the recent history and findings in each case.

While diabetes is not a common complication of hyperthyroidism, the rather frequent occurrence of glycosuria renders the accurate decision as to the presence or absence of this condition of extreme importance. During the year 1925, of the 700 patients operated for thyroid disease in the Lahey Clinic, 17 had a glycosuria of sufficient significance to be classified; of these 13 were true diabetics, 3 were potential diabetics, and 1 was a renal glycosuric. These cases have been carefully followed by the diabetic service of Dr. E. P. Joslin, and those which have proved to be true diabetics have been treated with insulin. Since operation 3 have discontinued their insulin and 2 have been able to reduce the dose. In none has there been a progressively downward tendency after operation, but, on the contrary, the majority have shown a greater increase in tolerance than the average diabetic. In Dr. Joslin's opinion the prognosis of the thyroid diabetic must be guarded. Every thyroid patient with glycosuria should be considered a potential diabetic for life, even though symptoms have been alleviated by partial removal of the gland. There is no marked increase in the risk of thyroid operations upon diabetics who have been prepared with insulin and proper diet provided they have not recently been in coma. When this complication has occurred shortly before operation the patient's ability to withstand surgery is materially reduced.

Hamilton has already reported the effect of thyroid toxicity on the heart based on a personal study of this problem in this clinic for the last six years. Thyroid toxicity drives hearts. The heart rates alone show this by commonly rising to extraordinary heights under ordinary stress. Rheumatic infections and heart diseases are proportionately high among thyroid patients, and some young hearts will fail because of these com-

plicating conditions. Patients with young sound hearts, however, tolerate this thyroid drive. Even though driven to death by the intoxication, they do not die a true cardiac death. Many of the older or coincidentally damaged hearts, however, are driven into auricular fibrillation. This is almost never found among thyrotoxic patients under twenty years of age, and only an occasional case between twenty and thirty years will have it, no matter how severe or prolonged the toxicity. But in each older decade the percentage increases until more than 85 per cent of the thyrotoxic patients who are over sixty years of age have auricular fibrillation. Altogether about 35 per cent of the definitely toxic patients in our clinic have auricular fibrillation at some time during observation. Under no common strain or disease does such a high percentage of cases develop this disorder.

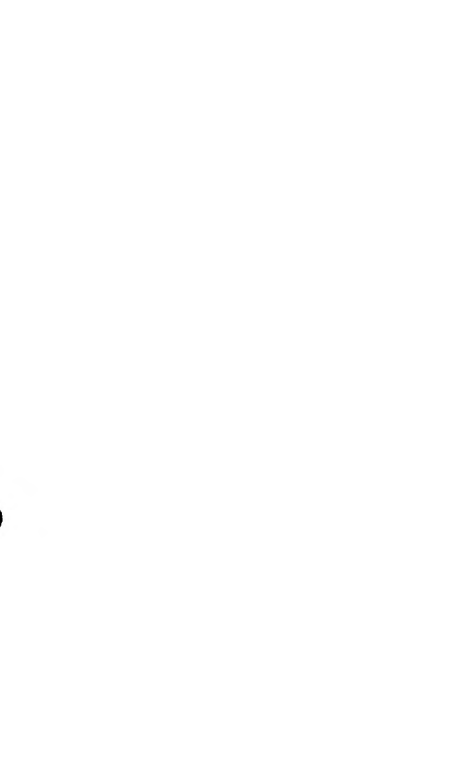
Thyrotoxic patients with auricular fibrillation deserve special care. It is in these cases, and in these cases only, that we have found appreciable benefit from thorough digitalization. Many details of rest and care to remove all unnecessary burden on the already dangerously burdened heart must be enforced. This group is particularly fragile. An occasional individual will die suddenly and unexpectedly without cause to be found at autopsy, an occasional case may have an embolus from an intracardiac thrombus. The most common danger is from the development of true *congestive heart failure*. A large portion of the patients with transient attacks of auricular fibrillation and a larger portion of those with established auricular fibrillation, have congestive heart failure shown by swollen livers, orthopnea, rales, cough and often a general edema. This group is distinct from the group presenting the picture of the thyroid storm without congestive heart failure previously described.

Hamilton finds that the important aspects of medical treatment of the heart in thyrotoxic states are: *First*, the search for an obscure underlying thyroid toxicity in certain cardiac conditions.

Second, the realization that while medical treatment can improve the heart condition temporarily in the majority of cases, it fails to give permanent results. In particular, one wastes

time and increases risk by prolonged medical care with digitalis quinidin, rest etc , in an attempt to relieve paroxysms of auricular fibrillation due to thyroid toxicity When cases with established auricular fibrillation and even with congestive heart failure are properly prepared they can be tided through a thyroid operation with a mortality of less than 3 per cent Proper removal of the thyroid gland results in a permanent cure of the pure thyroid heart

Satisfactory results in the treatment of hyperthyroidism must be based upon an accurate diagnosis of thyroid toxicity intensive study of the individual case, rational preoperative management carefully organized surgery, and personal care following operation Surgery is the only procedure of demonstrated merit for the cure of hyperthyroidism Its so called failures are due to inaccurate diagnosis or inadequate operation



REMOVAL OF THE CERVIX IN HYSTERECTOMY FOR BENIGN LESIONS

FRANK H. LAHEY

IN the July, 1923 number of the *Annals of Surgery* we published a description of a method of removing the major portion of the cervix in hysterectomy for benign diseases by transcervical excision, without danger to the uterus, without shortening the vagina, and without adding to the time necessary for the usual supracervical hysterectomy.

We have now performed this operation on 86 patients, with marked satisfaction. It has practically all the advantages of a complete hysterectomy in that the greater part of the cervix is removed, with none of the disadvantages.

After the uterine appendages have been tied off and cut, and the uterine arteries on either side of the cervix clamped with Ochsner clamps and cut, the uterus remains attached only by the cervix. An incision is made in the anterior surface of the cervix and grasped with double hooks and a similar one made in the posterior surface and likewise grasped with double hooks. This incision is made only to a depth of about $\frac{1}{8}$ inch, and completely encircles the cervix. By traction on the uterus and by continuation of the incision downward—remaining always only about $\frac{1}{8}$ inch from the outer wall of the cervix—that structure is gradually pulled upward and dissected from its shell just as the finger of a tight glove is everted by the extraction of the finger from it. The whole cervix is finally extracted, a gauze strip pushed through the shell of the cervix into the vagina, and the stumps of the broad and round ligaments sutured into the cavity left by the removal of the cervix.

There is often considerable oozing, which may be readily controlled by a mattress-suture passed from behind forward and back again, to be tied on the back of the cervical shell.

It has been necessary a few times to suture the lower end of the cervical shell through the vagina because of unusual oozing. This has, however, always controlled bleeding, as there have been no cases in which any serious oozing has taken place.

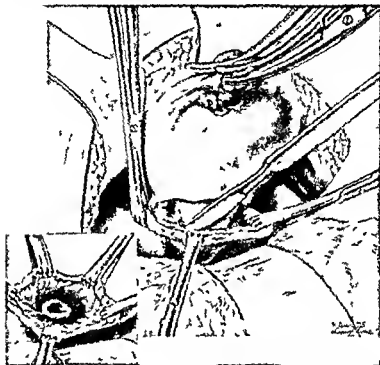


Fig. 213—Showing method of excising cervix and leaving behind a thin shell of its wall. Insert shows the shell and pocket with the vaginal opening at its bottom.

The disadvantages of this procedure have been the increased oozing and the occasional necessity of suture of the cervical shell from below.

The advantages are that practically all of the cervix may be removed together with the fibroid or uterine fundus without shortening the vagina, lessening the danger of malignancy in the cervical stump, and the cervical canal with its frequently persisting endocervicitis is removed, a cavity remaining in the

cervical shell into which the structures holding up the vagina and bladder may be deeply implanted so that good suspension is



Fig 214 —Uterus with the excised cervix



Fig 215 —The same uterus as shown in Fig 214 with the cervix split to show completeness of removal

obtained The operation may be done without added danger to the uterus with only two or three minutes' time added to the operation.



THE EFFECT OF IODIN ON THE PATHOLOGY OF EXOPHTHALMIC GOITER

RICHARD B. CATTELL

SURGEONS have long recognized the occurrence of atypical glands in exophthalmic goiter. There have been many reports of so-called colloid glands found in patients suffering from severe Graves' disease. Such observations are by no means limited to the earlier thyroid surgeons, several instances occurring even in the current year. An attempt to explain such findings, both by surgeons and pathologists, has led to much confusion in understanding the pathology of this condition. The pathologist has been prone to call glands with slight hyperplastic changes as beginning or mild exophthalmic goiter, while in the case of colloid glands in this condition both the pathologist and surgeon have in many instances joined in believing that there was a mistake in diagnosis.

With the reintroduction of the use of iodine and its wide general use, these discrepancies become explained. In the four years that iodine has been extensively used, there have been sufficient clinical and metabolic reports to show a fairly uniform result of iodine feeding, yet the changes in the gland have been rarely reported. Early in its use in this clinic we were impressed at the time of operation by the appearance of the glands which had had a preoperative course of iodine therapy in contrast to those receiving none. The ease of operability due to the decreased vascularity and the slight postoperative reaction were impressive; in addition, the glands were extremely friable due to the increased colloid content, making it difficult to grasp the gland with instruments for the purpose of displacing it. These differences led us to make a comparative study of a series of glands with and without iodine, as well as a controlled series of

the changes *both chemical and pathological* in the gland of the same patient before and after iodin (This was done by multiple stage procedures) These findings we have reported in detail elsewhere¹

Before the use of iodin a fairly constant pathologic picture was associated with exophthalmic goiter This goiter is of a symmetric bilateral and uniform nature The palpated gland feels soft and compressible due to the large volume of blood in the enlarged vessels This is in contradistinction to the gland after removal when it is firm due to the collapse of the vessels with the loss of the engorged blood The gland is regular in outline or marked by coarse lobulations The surrounding connective tissue is not thickened On section it is grayish pink or reddish brown in color has a meat like surface with fine lobulations and a very granular appearance The acini can rarely be made out with the unaided eye or if visible are greatly decreased in number This same gland microscopically shows an almost solid cellular structure The epithelium is high columnar with vesicular nuclei near the attached border and there is a pale finely granular cytoplasm The mitochondria by appropriate stain are greatly increased in number The acinar spaces are encroached upon by the uneven overgrowth of the epithelium so as to produce papillary projections The colloid content is greatly diminished or absent when present is unevenly distributed The connective tissue elements of the stroma are increased The blood vessels are enlarged especially on the surface and many capillaries are found throughout Infiltration with round cells is common beginning diffusely later forming true lymphoid follicles This is more marked in severe long standing cases with replacement of the epithelial elements at times giving the anatomic appearance of myxedema

In contrast to this well recognized usual picture after sufficient iodin feeding changes take place in a reverse direction

¹ Cattell R. B. The Pathology of Exophthalmic Goiter After Iodin Administration (Chemical and Histological) Boston Med and Surg Jour 1925 192 989 The Relation of Iodin to Certain Pathological States in the Human Thyroid with Especial Reference to Exophthalmic Goiter (In press) Proc New York Path Soc 1925 25 No 623

te, a return toward the normal appearance (involution) The gland becomes firm and usually decreased in size, although at times it is said to be increased After removal this gland feels definitely softer than the hyperplastic one, due to the deposition of the semifluid colloid It has the same regularity, but is yellowish brown in color The cut surface is moist, with few trabeculae Numerous acini can easily be made out and a viscid fluid may be forced out by hard pressure If a thin section 1 to 2 mm thick be cut from this gland, it will be found to transmit light and show only a fine supporting framework Such sections from a patient undergoing two hemithyroidectomies six to eight weeks apart, with iodine during the interval, show a marked contrast (Fig 216) The one before fails to transmit light, presents no acini, and does not reveal its structure, the other, after iodine, is clearer, due to the large amount of colloid and small cellular elements

Microscopically, sections from a completely involuted gland show acini slightly larger than normal, filled with a deep staining colloid The epithelium is low cuboidal or flat, with a small amount of cytoplasm and small dark nuclei The acini are more regular in outline with only few residual papillary projections Numerous lymphoid follicles and diffuse round cell infiltration remain The blood vessels are inconspicuous and show thickened walls, tending to obliterate them The stroma is nearly normal, yet has a few fibrous scars This apparent great change in the stroma suggests autolytic changes and shrinkage, as well as to indicate that the solid appearance of the hyperplastic gland is mainly due to epithelial proliferation Several photomicrographs illustrating these changes, in a controlled series will be found in our previous papers Reinhoff, in a controlled study of 3 cases, found similar changes, in a more general way others have recently noticed this anatomic effect of iodine In reviewing the sections from the glands removed before the introduction of iodine, an occasional instance of a colloid type of gland and in several instances a slight hyperplasia were found in our series, yet many of these had presented a severe clinical picture These we now believe had received iodine in some form

The hyperplastic glands have a consistently low iodine value, ranging from 1/10 to $\frac{1}{2}$ (0.3-1 gm) of normal. (The normal value should be considered as 2 mg per gram of dried gland) The iodine content of the glands following iodine administration

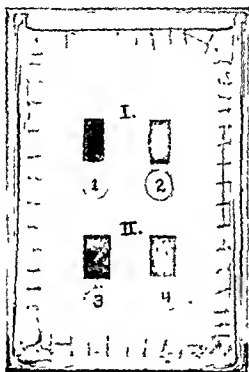


Fig 216 —Photograph of transilluminated sections from the thyroid before and after iodine one half natural size Patient I Section 1, gland at first hemithyroidectomy No iodine Very hyperplastic Iodine content 0.28 mg B M 48 Section 2, second operation, eight weeks later, with small amounts of iodine Moderate involution Iodine content 1.5 mg B M 40 Patient II Section 3, iodine eight days before operation Early involution Iodine content 1.3 mg B M 69 Section 4, second operation eight weeks later with iodine Marked involution Iodine content 7.9 mg B. M 35

was increased in every instance The involuted glands have a consistently high value, in one instance four times normal (8.4 mg) The large range of iodine values for involuted glands is confusing unless the microscopic appearance is considered.

After estimating the degree of involution, we found that the iodine values bear a close relation. In all glands in which there was over 3 mg. the involutional changes were marked, but varied greatly. Below this figure the iodine value and the degree of involution varied directly; in these glands the iodine could be

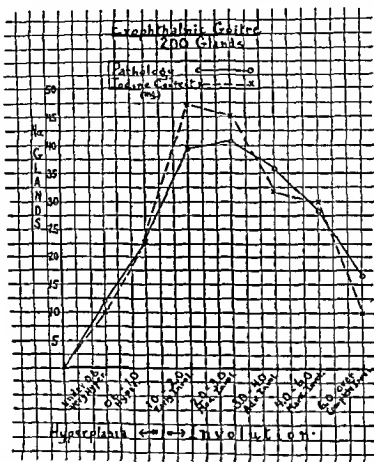


Fig. 217.—The relation of iodine content to the pathology. Iodine values and pathologic structure are plotted on the abscissa. The incidence of each plotted on the ordinates

roughly estimated from the section. It is to be expected, however, that much of the iodine stored was not in the form of "thyroid iodine" since feeding was continued up to the time of operation.

The accompanying graph (Fig. 217) illustrates the close relation between the iodine value and the histologic structure,

MANAGEMENT OF TOXIC GOITER

FRANK H. LAHEY

THE views regarding the management of cases of primary hyperthyroidism as expressed in *The Surgical Clinics of North America*, December, 1925, have been so materially modified by the introduction of iodine that our present plan of management of toxic cases is here presented

The necessity for care and critical study of cases of suspected hyperthyroidism still obtains. In fact as we have repeatedly stated in the past year, the use of iodine has been so enthusiastically accepted by the medical profession that any patient who has goiter, thinks she has goiter, or may have goiter has had what used to be called a course of iodine. As we have often, in our writings on this subject stated the determination in obviously neurotic individuals as to whether or not an already existing neurotic or psychiatric condition is complicated by a coexisting thyroidism may tax the resources of the most skilled and experienced thyroid observer. Where the patient has been taking Lugol's solution over a considerable period of time before coming for observation it becomes an even more difficult and confusing situation. Under such conditions we have not infrequently sent such patients home to be off iodine treatment for one month and to then return for observation and basal metabolic studies.

The management of patients with primary hyperthyroidism or exophthalmic goiter today in the clinic consists of preoperative rest and Lugol's solution until it is evident that the most marked degree of gain has been made, as evidenced by improvement in symptoms and drop in basal metabolic rate. A large number of those cases have shown this improvement in from eight to twelve days, although there is no fixed period of time which is allowed for this preoperative rest and medication, 92.8 per cent have

shown a definite drop in basal metabolic rate, 7.2 per cent have shown no drop or have shown an increase in basal metabolic rate.

This preoperative rest and preparation with iodine has resulted in the past year in a markedly diminished number of multiple stage operations. During the year 1925 754 thyroid operations were performed upon 680 patients 290 of whom suffered from primary hyperthyroidism or exophthalmic goiter, 138 secondary hyperthyroidism or toxic adenomata, and the remainder non-toxic adenomata, cysts, multiple colloid adenomata and malignancy. All of the multiple stage procedures were related solely to the toxic goiters. There was one preliminary pole ligation and 53 patients were operated upon by two stages—a right and left subtotal hemithyroidectomy.

When one recalls that previous to the employment of iodine but 38 per cent of our cases were operated in one stage it is evident that the preoperative preparation of patients by rest and iodine has very remarkably modified the plan of procedure. There were 8 deaths among all cases operated upon for thyroid disease last year 1 from typhoid hemorrhages—admitted directly from another hospital with severe thyroidism without symptoms of typhoid, operated for goiter, recovering from the subtotal thyroidectomy with development of typhoid and positive blood and Widal death thirty days after operation. One from embolus. The mortality rate being in primary hyperthyroidism 2.06 per cent, secondary hyperthyroidism 1.38 per cent, and non-toxic goiters 0 per cent, estimated upon a patient basis.

There are certain factors regarding the preparation of patients with primary hyperthyroidism by the use of iodine which from our experience should be particularly emphasized to the medical public. Iodine is of great value in saving those individuals who are suffering from the severest form of thyroid intoxication as evidenced by delirium, vomiting, diarrhea, and excessive excitation. This is a state that usually results from the medical attendant's procrastination and is a direct reflection upon his judgment and policy if it occurs, since almost none of these cases reach this alarming state without previously having had the

disease for some time in a more mild and practically safe operative stage

The use of iodin however, as a method of treatment of primary hyperthyroidism with the aim of cure, from our experience, is not a logical one. We have repeatedly administered iodin to patients upon whom we had previously operated for primary hyperthyroidism and removed insufficient thyroid tissue, resulting in a persisting thyroidism. In none of these cases have we been able to cure this persisting thyroidism with iodin and all have required further operation and removal of thyroid tissue to bring about a cure.

From our point of view it would be ideal if we could receive the patients with primary hyperthyroidism those with hyperplastic thyroids before they had received any iodin a condition which we almost never see now, so universally is iodin administered to goiters of all types. Iodin as a preoperative medication when effectual appears to accomplish its greatest good within a period of approximately two weeks. Following this there is a period when there is no further improvement, and beyond this a period when a great many of the cases lose a good part of the improvement which they have shown under the administration of iodin. When the patients come to the clinic after having had iodin for considerable periods of time it is doubtful if the same degree of preoperative improvement is accomplished with this drug.

Another advantage of receiving the patient for operation free from iodin treatment is, first, that those who are to handle the operative cure of the toxic thyroid patient are able to observe and be impressed with the degree of toxicity which the patient presents before iodin is administered, and second that they may recognize and obtain the full extent of gain from this method of preparation.

These factors, in our experience, are extremely important since we have seen many patients with severe hyperthyroidism who under iodin and rest were made quite calm persons, with lowered pulse rates and lowered basal metabolic rates, apparently good operative risks, and yet capable as we have had demon-

strated to us to our sorrow of showing serious and even fatal postoperative reactions entirely out of proportion to their apparent preoperative state of operability. We have urged therefore that complete operations be undertaken upon toxic goiter patients only after a consideration of what their state was previous to the administration of iodine when they were at their worst and that limited procedures such as hemithyroidectomy, be undertaken if the slightest doubt exists as to their ability to stand the entire procedure. We still feel that pole ligation, while rarely necessary, has a place in those patients coming to the clinic for operation in the severe stages of hyperthyroidism. We have lost 3 patients with severe hyperthyroidism following first stage hemithyroidectomy and we have never had this happen without the feeling that had we undertaken a lesser procedure such as pole ligation the fatality might not have occurred.

It must distinctly be admitted that the intensely toxic thyroid patient is a dangerous risk, often capable of unsuspected possibilities in the way of serious postoperative states. With this admitted and only the inexperienced would deny it, very little stress can be placed upon the advantage of a single stage operation. We feel that this statement bears additional weight in this clinic when we say that we have never had a patient with severe hyperthyroidism die following the second stage hemithyroidectomy. If they have been able to endure the first stage hemithyroidectomy they have been able to endure the second, either because they were no worse or very decidedly better. We have seen no patients show intensification of toxicity between the two stages of first and second hemithyroidectomy. Were we able to operate 50 patients with intense hyperthyroidism or 100 or even more in one stage and should one die, we would consider that we had used poor judgment upon the remainder since the death of one under the same conditions of judgment means that many more of the remainder were capable of the same unappreciated degree of fatal reaction. Never in our opinion should the matter of the patient's wish or convenience be permitted (they tend to markedly) to sway one's judgment in the slightest degree toward a single stage procedure.

So much has been written and said regarding the elimination of multiple stage procedures by the use of iodin that the value of the divided operation upon these frail risks tends to be diminished and lost sight of. One or two possibly added steps leave one only with the possible regret of overcautiousness, not to be compared with the regret and responsibility which attends the lack of this attribute in relation to the surgery of intensely toxic thyroid patients. When, in addition to this we assess the mortality of each course and find that the conservative plan has a mortality rate in this clinic which is small compared with the more daring plan then for us there is no question as to the choice of plans in the doubtful case.

As a final word regarding the use of iodin in toxic goiters, we have previously urged that there are few surgical conditions in which mortality rates are so dependent upon estimation of operability and the extent of operability as in toxic thyroid states. This judgment may be acquired in our estimation only by a prolonged and constant contact with patients suffering from these states of thyroid intoxication and their reaction to surgical procedures. It is not a situation that permits of laying down a set of rules by which one may be guided solely. It requires that each case be weighed and debated individually, and that every markedly toxic thyroid be submitted to surgical procedures with the possibility of a fatality in mind, and weighing heavily in selection of the course and plan of the surgical procedure employed.

The above remarks are made not only for what value they may have to those relatively inexperienced with toxic thyroid states, but also that we may urge that any change from a multiple stage plan of dealing with these patients untreated with iodin should be made with the utmost caution and only after a considerable experience with operations upon patients who have been on iodin treatment. If we tend to repeat this warning it is only because we know that the transition from operating upon toxic thyroid patients untreated with iodin to operating upon those treated with iodin has doubtless resulted in many fatalities that might have been avoided had less dependence been placed

upon the occasional false security obtained by preliminary iodine feeding and more trust exhibited in the continuation of cautious operative approach

The patients are still given preliminary drugging with scopolamin and morphin—scopolamin now but one dose of 1/200 and two doses of morphin gr $\frac{1}{8}$ to $\frac{1}{4}$ two hours and one hour previous to operation. Doubtful cases have but one side of the gland exposed for removal so that should the course of the operation indicate an unfavorable reaction on the part of the patient the neck may be closed and the remaining lobe removed six weeks later

As was the original plan in any case in which doubt exists as to a severe reaction a lesser stage than was originally contemplated is done

In conclusion we wish to urge strongly that multiple stage procedures be still employed where the slightest doubt exists as to the outcome of the operative treatment and that every toxic death following an operation for toxic goiter be frankly admitted as due to poor surgical judgment should it occur when a lesser surgical procedure could have been employed

ESOPHAGEAL CASES

D CROSBY GREENE

DURING the years 1924 and 1925 a series of 30 esophageal cases have been treated at the New England Deaconess Hospital. These are divided into the following groups

Carcinoma	11
Stricture	8
Foreign body	6
Diverticulum	3
Card spasm	2
Total	30

The esophagoscope was used in all cases to establish the diagnosis and in most instances to carry out the treatment

CARCINOMA

The 11 cases in this group were all in an advanced stage of the disease and the treatment was entirely palliative. Gastrostomy and radiotherapy were advised, but in only 4 cases was consent for operation given. In these 4 cases there was an undoubted prolongation of life for three or four months as shown in the following illustrative case

Mr G D B, aged sixty three years, consulted us on February 27, 1924, complaining of increasing difficulty in swallowing during the past three months with recent considerable pain. \times Rays (Fig 218) showed obstruction to the passage of barium mixture at the level of the sternal notch and the irregularity of constriction characteristic of malignant disease. On March 4th esophagoscopy was done under ether anesthesia. An obstructing growth was encountered at 20 cm from the incisor teeth, a hard, irregular, ulcerating tumor, the upper portion of which projected like a lip into the lumen from the anterior wall. A specimen was removed for biopsy, and a bougie, No 26 French, was

passed with slight resistance through the stricture. Five seeds of radium emanations each 1 mc. were inserted into the growth at different parts. Following this treatment the patient suffered considerable pain and was able to swallow hardly at all for three days during which time fluids given by rectum. Gastrostomy was then performed on March 7th. From that time until his death four months later he subsisted entirely on nour



Fig. 218.—Roentgenogram. Carcinoma of the upper third of the esophagus showing irregularity of constriction characteristic of malignant disease.

ishment taken through the gastrostomy tube. For two months he gained in weight and strength and was able to attend to his business affairs. Then gradually failed until his death two months later.

Comment.—The improvement in the patient's general condition after gastrostomy was marked and has in our experience been characteristic of the cases in which the operation was done fairly early and not as a last resort.

STRICTURE

The 8 cases in this group included 1 case of lye stricture, 5 cases of webs or bands at the upper or lower extremity of the esophagus, 1 case of multiple stricture of unknown origin, and 1 case of probably congenital stricture of the lower end of the esophagus

All these cases were with one exception treated successfully by esophagoscopy with dilatation by bouginage. The exception was a case where an adhesion just behind the cricoid cartilage, with anterior and posterior attachments divided the esophagus into two channels. The excision of this band by punch forceps resulted in complete relief of marked symptoms of obstruction with inability to swallow anything but liquids.

A stricture of moderate degree may result in complete obstruction by the impaction of a mass of unmasticated food at the point of narrowing, as shown in the following case.

Mrs. J. A. R., aged forty five years on December 6, 1924, consulted us on account of difficulty in swallowing which had troubled her for about five months and was gradually increasing. Food would go down, but shortly be regurgitated. At the time of her first visit she was regurgitating almost everything that she swallowed, including liquids. She was very weak and emaciated, having lost 40 pounds in five months. She stated that she remembered having had in previous years similar attacks when she regurgitated food but these had been of a few days' duration and had not interfered with her health. α Rays showed a moderate dilatation of the whole esophagus, and a constriction at the lower end at the level of the diaphragm (Fig. 219). On December 8, 1924 esophagoscopy was done under ether anesthesia. The esophagus was found moderately dilated, but no other marked abnormality was noted until at the lower end, about 35 cm. from the incisor teeth a mass of foreign material was encountered, which on removal proved to be decomposing chicken meat. The lumen was constricted to about 1 cm. at a point just below the lodgment of the foreign body, but this was readily dilated with bougies up to size No. 46 French. Recovery was uneventful.

This patient has returned for observation and bouginage at gradually increasing intervals from two weeks to three months. She has regained her lost weight and experienced no further serious obstruction to swallowing.

Comment—The stricture in this case was probably congenital and of a moderate degree. It manifested itself only after



Fig. 219.—Stricture of the lower end of the esophagus. Moderate dilatation of the whole esophagus above the stricture.

the ingestion of a large bolus of food which became impacted at the stenosed region. Owing to the readily dilatable nature of the stricture and the dilatation of the esophagus above it, this case might be considered as one of cardiospasm, but it seemed to us that the stricture was organic, probably congenital in origin, and should be so classified.

FOREIGN BODY

Foreign bodies recovered from the esophagus were a safety-pin, a piece of wire, a fishbone, a lobster shell a piece of meat, a ring, and a nickel, the last two were both impacted in the same case above a stricture of the middle third of the esophagus. In 2 cases the foreign body was not recovered. In the first a piece of meat which almost completely obstructed the esophagus was dislodged spontaneously before it could be found. In the second case a safety pin was found, but attempts at extraction failed.

Robert V, a seven month old infant, was brought into the hospital on June 19, 1925, having swallowed a small safety pin six days previously. The child had taken its nourishment regularly but appeared fussy and cried a good deal. There was no fever. \times Rays showed the pin in the esophagus just below the level of the sternal notch, the point up and turned to the left. Esophagoscopy was done, under light ether anesthesia and the shield of the pin located, but in the course of the manipulation for extraction the pin slipped from the forceps and was pushed down into the stomach. The course of the pin was then followed by \times rays. In two days it had apparently left the stomach but remained in about the same position below the stomach and a little to the right of the median line for about five weeks (Fig 220). Although the child was in good condition and showing no harmful effects, it was then decided to have a laparotomy done. However, \times rays taken the day before that set for operation showed no pin. It was never recovered and must have been lost in the stools. The \times ray picture taken on the thirty first day is here shown. An attempt to localize the pin by the injection of barium mixture through a rectal tube into the sigmoid resulted in a distortion of the sigmoid without showing its relation to the pin. The stomach appears distended with gas and the pin lies clearly below the stomach.

Comment—Safety pins in the esophagus which become dislodged and pass into the stomach usually pass through the gastro intestinal tract without harm in a few days. These cases should be closely followed by \times ray and careful physical ex-

amination with a view to laparotomy if any evidence of fixation or perforation appears. This case is remarkable on account of the unusually long sojourn of the pin in the intestinal tract without complications.

Another case not included in the series was that of a foreign body, a fragment of steel, embedded in the party wall between



Fig. 220—Safety pin in intestinal tract of eleven month-old infant thirty-one days after ingestion. The pin was discharged spontaneously a few days later.

the larynx and trachea just above the cricoid. This was an industrial accident case. The fragment of steel was a portion of a steel cylinder which had exploded from the excessive high pressure of a gas which it contained. The piece of metal was driven into the left side of the neck, passed through the larynx, and became embedded in the middle of the posterior wall of the

larynx. When admitted to the hospital on September 3, 1924 he was moderately dyspneic. *Laryngoscopic examination* showed congestion and swelling of the mucous membrane and marked limitation of movement of the cords, but no indication of the location of the foreign body. *x-Rays* showed the position clearly (Fig. 221). On account of dyspnea tracheotomy was done on September 8, 1924. On September 18th examination with the direct laryngoscope failed to locate the foreign body. It was



Fig 221 —Fragment of steel embedded in the posterior wall of the larynx
The foreign body was removed by median thyrotomy.

evident that it was completely buried in the tissues at the back of the larynx, and it was decided that the search should be attempted by external operation. Two methods of approach were tried: the first, by a lateral incision, proved to give inadequate access to the region involved; the second approach, through a median incision splitting the thyroid cartilage longitudinally, provided an easy access to the posterior wall where the foreign body was readily located and dissected out.

DIVERTICULUM

Three cases of diverticulum were examined esophagoscopically. Two of these were cured by subsequent external operation.

Mrs E A B, aged seventy five years was first seen by us on March 28 1924 when she was brought to the hospital as an emergency case with complete obstruction of the esophagus, having been unable to swallow water for two days. She said that for many years she had been obliged to chew her food thor-



Fig. 222.—Pulsion diverticulum of esophagus.

oughly in order to swallow it but had had no serious difficulty until four days previously when eating meat she experienced discomfort and marked difficulty in swallowing which increased so that she was unable to take even liquids. X Rays taken on admission (Fig. 222) showed a large diverticulum of the upper end of the esophagus at the usual site. Esophagoscopy was immediately done under ether anesthesia. The scope was readily passed into the sac and the normal opening discovered by the aid of Mosher's ballooning device. It appeared as a small pinhole opening in the upper part of the anterior wall of the sac.

a little to the left of the midline. This opening was dilated readily with bougies up to No. 34 French. Following the dilatation the patient was greatly relieved for about one month, after which there was gradual return of her difficulty. She was recommended for external operation for cure of the condition, and was admitted to Dr. Lahey's service on September 19, 1924. He operated upon her by the two-stage method. Since then she



Fig. 223.—Multiple stricture with irregular dilatation and sacculation of entire esophagus

has reported for observation and bouginage at intervals of two or three months. There has been no return of symptoms of obstruction.

Comment.—By the aid of Mosber's ballooning device it is possible to readily locate the normal esophageal opening which is otherwise in many cases extremely difficult to find. If the normal opening is found and dilated considerable temporary relief may be expected, but permanent relief can only be obtained by external operation and removal of the sac.

CARDIOSPASM

The cases of so-called cardiospasm have presented some difficulties in locating the cardiac orifice at the lower end of a dilated and sacculated esophagus. We have found Mosher's esophagoscopic ballooning device of great assistance in finding the normal passage into the stomach in such cases. Once this has been recognized, its dilatation by bouginage has been a simple procedure and effective in the relief of obstruction.

THE CHRONIC CARDIAC AS A SURGICAL RISK

BURTON E. HAMILTON

AMONG general surgical cases not of an emergency nature, excluding thyrotoxic patients where the percentage of heart complications is high, about $7\frac{1}{2}$ per cent of all the patients of all ages are found to have something in history or physical examination to cause the heart condition to be considered if routine examination is made and history taken before operation.

It is possible to group these patients into three divisions

(A) Cases that have *no serious disease of the heart*

This group consists principally of (1) Individuals that can be classed as having *neurasthenia* with *symptoms referred to the heart* (a *cardiac neurosis* or a *neurocirculatory asthenia*) Their complaints usually include some of the following

(a) "*Heart Pain*"—Painful twinges or soreness or aching, usually subcordial or precordial—rarely substernal or referred to neck, arm or arms—often most bothersome during excitement or exertion and yet bearing no constant relationship to exertion.

(b) *Breathlessness*—This may be associated with exertion or excitement but is apt also to be definitely associated with phobias—sensations of breathlessness or smothering experienced in crowded or closed places.

(c) *Rapid Heart Beat*—Persistent, or only on excitement or exertion, but not coming in clear attacks of sharp onset and offset and the rate (though it may never be found below 100) distinctly fluctuating with exertion and rest. There is also often unpleasant consciousness of the heart beat—palpitation.

(d) *Increased fatiguability*—feeling of "weakness," giddiness, faint feelings—even an occasional syncope.

In addition, there may be cyanosis, usually of hands and feet, and not general. And often, in addition, sleeplessness, sensations of discomfort in the back of the head, of a tight band across the forehead.

CARDIOSPASM

The cases of so called cardiospasm have presented some difficulties in locating the cardiac orifice at the lower end of a dilated and sacculated esophagus. We have found Mosher's esophagoscopic ballooning device of great assistance in finding the normal passage into the stomach in such cases. Once this has been recognized its dilatation by bouginage has been a simple procedure and effective in the relief of obstruction.

heart beat slow They may occur even with rapid heart rates in some individuals They can be recognized as extra heart beats In most cases they are followed by a "compensatory pause," the fundamental regular rhythm of the heart being interrupted but not altered by them They are to be differentiated from auricular fibrillation and (a much less common disorder) true dropped heart beats When diagnosed accurately extrasystoles may confidently be regarded (if the heart examination shows none of the important evidences of disease) as of no significance in surgical risk An occasional case has extrasystoles very frequently—at nearly all examinations and even when the heart is beating at fairly rapid rates—occasionally in such patients there will be pairs of extrasystoles (and, rarely, more than two in succession), the intervals between these pairs or runs of abnormal beats being very short The whole group of patients having extrasystoles as the only abnormal point in cardiac examination or those who have in addition, only the complaints enumerated under the group described as "neurocirculatory asthenia" or "cardiac neurosis" withstand surgical strain as well as normals I have watched particularly the small group of patients with very frequent extrasystoles and those who also have them occasionally occurring in short runs of two or rarely more and these individuals have withstood the strain of surgery (and of pregnancy) successfully It seems hard to believe that when an average of one heart beat out of every three or four is abolished and replaced by a probably largely wasted effort that the heart can perform its duty satisfactorily under prolonged strain Nevertheless actual cases, some of them well along in years (I have in mind cases over seventy and many in the sixties), with otherwise reasonably sound hearts, have stood the strain of major surgery and convalescence well Even the aggravated cases of extrasystoles demand no special precautions or heart stimulants

It is wise to explain the heart irregularity in such patients to anesthetist, nurses and others who will watch the pulse through and after operation in order to avoid unnecessary apprehension

(B) Another less clearly marked group of suspected cardiacs may be classed as "*possible heart disease*"

This group can include patients with more or less clearly audible systolic murmurs of different qualities of location, transmission, pitch persistence etc. Many of these patients know that they have a heart murmur—usually they have caught the phrase that they have a "leaky heart." Some have been rejected at life insurance examinations. Naturally they are apprehensive.

To this group with systolic murmurs and no other evidence of heart disease may be added others who have a prominent apical first heart sound (sometimes mistaken for a presystolic murmur and used as a basis for a wrong diagnosis of mitral stenosis) split or reduplicated sounds or third heart sounds. Any combination of the above and in addition a suggestion of "doubtful" or "slight" enlargement may be encountered. Some of this group have a clear or probable history of rheumatic fever or chorea. It is probable that some of the hearts in the whole group are damaged and that most of them are not. In any case this group roughly classifiable as "possible" or "not diagnosable" heart disease, or in some cases "possible" or "potential" rheumatic heart disease exists. If the clear points justifying a diagnosis of a significant heart disease are absent, such a group as a whole offers no apparent increased risk to surgery. To collect data on this particular group I have kept a record of a long series of cases that I have examined personally through the prolonged strain of pregnancy and labor or operative delivery, and no case has decompensated. Of 170 consecutive cases there was 1 death of puerperal sepsis in a case also complicated by signs of toxemia. The heart did not fail.

(C) Patients with *significant heart disease*

Close to 2 per cent of a general surgical clinic, excluding the patients with thyroid disorders, have a significant chronic heart disease. Though one cannot briefly state all the criteria for significant chronic heart damage such "true" cardiacs as a rule with very few exceptions have one or more of the following points

- (1) Clear enlargement
- (2) A significant disorder of the heart beat

- (3) Signs or history of heart failure
 - (a) Of the congestive type (decompensation)
 - (b) Of the anginal type (angina pectoris)

(The only important group of chronic cardiacs of a diagnosable and surgically significant nature that does not always have one or more of the above points is a small group of patients who can be diagnosed as congenital, or probably congenital heart)

True cardiacs, patients with *significant chronic disease of the heart* in my experience form the largest and most important single group of patients who have coincident chronic disease within a general surgical clinic

It is not possible, however, to discuss in a valuable way the risk of such "cardiacs" in major surgical operations as a single group. Just as, clearly, one cannot discuss "lung diseases" in a single group. There are several disease groups into which the true chronic cardiacs fall. The most important groups are

- (1) Rheumatic heart disease
- (2) Heart changes associated with hypertension
- (3) Degenerative senile, or *arteriosclerotic heart disease*

Hearts seriously damaged from *cardiovascular syphilis* are much less commonly found in surgical clinics, and *congenital hearts* also form a very small though, in my experience, an important group. (There are, of course, some cases with combined pathology.)

Without going to considerable detail the rules for differential diagnosis of "true" cardiacs into the essential divisions of etiologic groups cannot be stated. There is no way of making the diagnosis of cardiac disease a very simple matter. If the 7½ per cent made up of suspected cardiacs is to be thoroughly handled in a surgical clinic, the individuals must be examined and classified by someone specially trained in diseases of the heart.

RHEUMATIC HEART DISEASE (CHRONIC)

Though this heart disease can be elaborated into a number of subgroups it is of value to discuss it as a whole.

Such patients (excluding those that have a rheumatic history, but whose hearts do not show one of the four points enumerated

above) as a group do not have as long an expectation of life and do not stand strain (for example, pregnancy) so well as normals

Out of 136 cases with definite rheumatic heart disease that I have personally examined and followed through major surgical procedures, there have been 6 deaths directly associable with operation or convalescence

The actual percentage of deaths is of little importance. It may well be misleading because of the differing "normal" death rate in the various types of operations included. The patients were all subjected to major operative procedures, carrying an appreciable 'normal' death rate. Twenty eight of them were pregnant and had cesarean section. As I watched the patients through strain of anesthesia, operation, and convalescence, the ease with which they bore the apparently severe strain was impressive.

This rheumatic heart disease group briefly consists of patients with enlarged hearts (only a very few have this sign alone), or mitral stenosis or aortic regurgitation, or some combination of these conditions. (The cardiac pathology from the history, the nature of the lesion or the age of the patient being best attributed to rheumatic disease.) They can readily be separated into

(1) A group which has not yet shown congestive heart failure (decompensation) or a significant disorder of the heart beat. (The common significant disorder of the heart beat in adults with rheumatic heart disease is auricular fibrillation.)

(2) Those with auricular fibrillation

(3) Those with signs or history of congestive failure

Fourteen had auricular fibrillation and no failure

Thirty six had congestive failure. (Sixteen of this 36 had both congestive failure and auricular fibrillation.)

Thirty one altogether had auricular fibrillation either established or in very frequent attacks. A number of others had brief attacks for apparently the first time following operation, without exception returning to normal rhythm before discharge from hospital.

Only one death occurred among the 87 patients without failure, decompensation, or auricular fibrillation. This patient had an enlarged heart and mitral stenosis. She had no clear

evidence of failure decompensation, but a history of frequent attacks of 'bronchial asthma'—which may well have been failure. She died instantly and unexpectedly six days after an abdominal operation for therapeutic abortion and sterilization. Two had mitral stenosis established auricular fibrillation and a history of probable failure, but no failure at the time of operation or for a reasonable time previously. One died unexpectedly and suddenly five and one half hours after leaving the table. The other died in a state of shock without clearly regaining consciousness following operation. The other three deaths might well be omitted in a discussion of operative strain. They were pregnant women with gross congestive heart failure who were operated close to term somewhat as emergency operation. One died after several days of general peritonitis and congestive heart failure. The other two died slowly of congestive heart failure.

It is clear that among the cases of rheumatic heart disease it is with those that have established auricular fibrillation, or a clear history or signs of failure, that the greatest risk from surgical strain lies. And in these cases some risk is unavoidable. Patients with rheumatic heart disease and established auricular fibrillation though many carry on with reasonable activity, are as a group distinctly fragile. (See later discussion of auricular fibrillation.)

Patients with severely damaged hearts due to rheumatic heart disease deserve to be handled with great care before, during and after operation. Those with auricular fibrillation deserve digitalization. Those with congestive failure present or recent may be operated upon confidently if they are very carefully prepared and handled during convalescence.

HYPERTENSIVE HEARTS

There are relatively few burdens that cause congestive heart failure except to hearts otherwise damaged, for example by rheumatic, degenerative or luetic disease. Hypertension is a serious heart burden, a large fraction of patients with hypertension die of congestive heart failure. Proper classification of cardiacs must include the hypertensive heart.

Everyone is aware that the kidney and blood condition in hypertension should be studied. Nowadays kidney function tests, blood chemistry examination and cell counts as a rule are easily available to a surgeon. Such cases also require a study of the heart condition other than by laboratory procedures. Briefly the heart condition in patients with hypertension is to be studied for

- (1) Enlargement
- (2) Failure
 - (a) Congestive
 - (b) Anginal
- (3) Disorders of the beat

Auricular fibrillation, the most important common disorder of the heart beat, throws off blood pressure readings and though patients with hypertension may develop auricular fibrillation they then are actually apt to be classed as cases with arterio-sclerotic heart disease and auricular fibrillation. (Clearly—see later—the kidney condition is to be studied in this latter group as well as in the hypertensive hearts.)

The most common significant disorder of the heart beat in patients with hypertension (and regular beat) is a *pulsus alternans*. This is discovered while taking the blood pressure as a slight difference in the systolic pressure of alternate beats. The timing of the beats is perfectly regular. The difference in pressure is often no more than 10 mm of mercury. Often the alternation signals to the examiner by an alternation in the strength of the sounds heard when approaching but below the systolic pressure level during blood pressure taking by the auscultatory method.

I have found in my records of cases whose heart condition I have examined with a view to determining operative risk 67 cases with marked hypertension and enlargement of the heart apparently secondary to this—clearly hypertensive hearts. The group contains 4 who had gross congestive heart failure and 2 with persistent alternation. Some had extreme degrees of hypertension. As it happens there was only one fatality though all had major surgical operations. The death occurred

in a patient who failed to regain consciousness after anesthesia and died rather abruptly after twelve hours. No autopsy was permitted. One case had hemiplegia two days after operation but recovered. The others stood operation and convalescence well. From my experience it appears that patients with hypertension and no gross kidney failure are generally regarded as not bad operative risks. One encounters an occasional patient who has been advised against needed surgery purely on the basis of an enlarged heart and hypertension. The cases do stand surgery well but it is scarcely to be expected that they can be as safe risks as normals and they justify careful estimation of their heart as well as kidney condition and care in preparation.

ARTERIOSCLEROTIC HEARTS

I have selected 37 patients whose cardiovascular condition I examined before operation with a view to determine operative risk and who had unmistakable significant heart damage which could best be attributed purely to arteriosclerotic changes. The principal points used in selecting this group were briefly absence of rheumatic or luetic history, absence of diastolic murmurs or hypertension, advanced age with often clear evidence of extracardiac sclerotic changes and one or more of the following findings:

- (1) Gross enlargement of the heart
- (2) Auricular fibrillation or *pulsus alternans*
- (3) Congestive or anginal failure

(Often there was also electrocardiographic evidence of myocardial disorder.)

The above 37 patients include many obviously poor cardiac risks. All had major surgical procedures. Three died. One had a large adenoma of the thyroid, chronic phthisis and established auricular fibrillation. She failed to return to consciousness after anesthesia and operation and died in about sixteen hours. A second case with *established auricular fibrillation* died suddenly during induction of anesthesia. Autopsy revealed no immediate cause for death but gross degenerative heart changes. The third with a grossly enlarged heart, no clear failure and a normal

rhythm survived gall bladder operation and appeared to be doing very well but on the twelfth day went into a state of shock and died two days later with symptoms of a coronary occlusion. Autopsy showed a very large heart with a large infarcting area (which must have antedated the operation).

The percentage death rate from the figures given means little. But it is clear that patients usually elderly even with gross heart changes attributable to arteriosclerosis with angina pectoris and with congestive failure (see later) can be prepared for operation and operated safely in the great majority of cases. Many of this group have in addition some evidence of kidney damage. In this group again the added surgical significance of an auricular fibrillation or failure or both appears.

Clinical cardiovascular syphilis is not a common complicating disease of surgery. I have personally seen but a handful of Class A cardinals justifying a diagnosis of cardiovascular lues who were operated. One of these cases had prolonged congestive heart failure only partly relieved by rest in bed for several weeks before operation.

CONGENITAL HEART DISEASE

Patients with congenital heart disease form a tiny but particularly interesting group of surgical risks.

In my own experience there has been what is probably an unduly large death rate and incidence of alarming unexpected symptoms following operation.

Altogether one can classify a small fraction of 1 per cent among children and young adults (rarely a middle aged or elderly patient) who require major surgery as having a definite or probable diagnosis of congenital heart. By far the largest number of these are cases that have a loud (and often sustained) systolic murmur with a thrill usually appreciated best at the left of the sternum toward the base or near the midportion of the heart and not transmitted to the neck. Some have as well a prominent pulsation with the heart beat to be felt at the left of the sternum toward the base of the heart. Distortion of the heart shadow on x ray plates or fluoroscopic examination or

abnormal ventricular complexes in electrocardiograms in some cases add weight to the probable diagnosis. This number, as a rule, have no clear cyanosis, and give a history of leading a normal life without impressive embarrassment referable to the heart.

A group of 22 such patients, including two with drumstick fingers and cyanosis, had major surgical operations resulting in 4 deaths.

(1) One survived one major operation and died of tetanus three weeks after a second major operation. (Scarcely a significant case in these series)

(2) A second case operated for a lung abscess died with cerebral symptoms; no autopsy.

(3) A third died six days after a laparotomy, suddenly and unexpectedly.

(4) A fourth case previously without clear disability, cyanosis or drumstick fingers, showed violent heart action with normal rhythm, rapid heart rate (130-160), and alternation of the heart beat; rapid deep respiration; pallor. There was no congestion. This continued for ten days after a cesarean section, when death occurred apparently from exhaustion. A few days before death she showed marked pulsus alternans. Autopsy showed a large opening in the interventricular septum, and no other cause for death

(5) A fifth case, with a sustained systolic-diastolic murmur, drumstick fingers and persistent cyanosis, but actually without marked disability, showed (suddenly) the same distress described in the last case immediately after cesarean section, and slowly recovered after several days.

It is dangerous to draw conclusions from small groups of cases that may prove to be very unusual. But in a considerable experience in observing the response of patients with significant heart diseases to surgical and obstetric strain, this small group of patients with congenital malformations stand out as furnishing some unpleasant surprises. Nevertheless, most of this small group tolerated surgical strain without the slightest cardiovascular embarrassment. One can hardly refuse them needed surgery.

AURICULAR FIBRILLATION

In considering the whole group of cardiacs it is evident that patients with *established auricular fibrillation* furnish a delicate class of patients for surgical strain. Most of them have severely damaged hearts in addition to the disorder of the beat. If one watches a large group of otherwise unselected patients with established auricular fibrillation (not including those with failure) outside of a surgical clinic one finds that many of them carry on with reasonable activity very well indeed. An occasional case however dies suddenly and unexpectedly without clear cause to be found at autopsy. An occasional case has a fatal embolus from a thrombus formed within the left heart. Some have evidence of an embolus and recover.

Nevertheless out of 150 unselected cases that I have watched who had established auricular fibrillation and were subjected to major surgical operations 143 survived. Many of these patients had congestive failure before operation and even at the time of operation. The group includes patients with rheumatic arteriosclerotic heart disease and many who were thyrotoxic.

The deaths were

Three sudden and unexpected (One autopsy failed to show cause.)

Three promptly (about twelve to twenty four hours) after operation in the general picture of shock.

One two and one-half days after operation with prolonged symptoms of distress suggesting shock.

Auricular fibrillation (see Sudden Alarming Sudden Symptoms Referable to the Heart Following Operation) is a significant disorder of the heart beat in fact the most important common disorder. It is clear that it does not in itself contraindicate surgery. It inevitably adds a slight risk. It indicates careful digitalization.

Discussion of the chronic cardiac as a surgical risk necessarily includes methods of preparing the patient for operations. Whether or not digitalis or other heart drugs are to be used is always to be decided. This is a much discussed question and its significance is probably overemphasized but it cannot be avoided.

The use of digitalis in surgery is not clearly understood.

The dosage is pretty well established. A grain and a half for every 10 pounds of body weight in twenty-four hours (or a single dose) and $1\frac{1}{2}$ grains daily thereafter of a standardized powdered leaf or its equivalent in some other form. But all digitalis taken within a period of about two weeks before digitalization is to be considered. Thin patients, in my experience, often require more, fat ones less, than their theoretic allotment per pound. (It is likely, as discussed by Pardee, that the size of the heart is a factor in dosage.) Some stay satisfactorily digitalized on $1\frac{1}{2}$ grains. Others require more. Occasionally a case will only tolerate a smaller amount, but standard dosage is distinctly worth bearing in mind.

Indications for the use of digitalis in surgical strain are a matter of opinion and authority. Experience apparently leads men who are qualified to speak to widely differing opinions.

Digitalis appears to me to be a relatively safe drug. With reasonable doses it is not uncommon to cause unpleasant general symptoms which clear without ill effects within a few days after its withdrawal. It is possible to poison hearts with it and do appreciable harm. This is very uncommon. The only cases that I have personally seen where I am confident that it has done serious harm when given in reasonable doses are a few individuals among patients during or convalescing from acute infections, particularly diphtheria, rheumatic fever, and some of the "prevalent epidemic infections." It is less easy to be sure that it has done real harm, though an occasional case suggests it (for example, by aggravating blocks, causing dissociation, or extrasystoles and paroxysmal tachycardia), in some individuals with chronically or acutely damaged heart muscle, from other causes than acute infections.

The "whip-like" action of digitalis on the heart is shown clinically rather indistinctly or at any rate inconstantly, and where such an action has been apparent there is often little solid evidence that the patient's general welfare has been materially aided by this action. Its blocking, slowing effect on normal rhythm is often not clear, and it is doubtful whether it is beneficial to slow by drugs a heart which is beating fast, but in a normal rhythm and as a normal response to a strain.

AURICULAR FIBRILLATION

In considering the whole group of cardiacs it is evident that patients with *established auricular fibrillation* furnish a delicate class of patients for surgical strain. Most of them have severely damaged hearts in addition to the disorder of the beat. If one watches a large group of otherwise unselected patients with established auricular fibrillation (not including those with failure) outside of a surgical clinic one finds that many of them carry on with reasonable activity very well indeed. An occasional case however dies suddenly and unexpectedly without clear cause to be found at autopsy. An occasional case has a fatal embolus from a thrombus formed within the left heart. Some have evidence of an embolus and recover.

Nevertheless out of 150 unselected cases that I have watched who had established auricular fibrillation and were subjected to major surgical operations 143 survived. Many of these patients had congestive failure before operation and even at the time of operation. The group includes patients with rheumatic arteriosclerotic heart disease and many who were thyrotoxic.

The deaths were

Three sudden and unexpected. (One autopsy failed to show cause.)

Three promptly (about twelve to twenty four hours) after operation in the general picture of shock.

One two and one half days after operation with prolonged symptoms of distress suggesting shock.

Auricular fibrillation (see *Sudden Alarming Sudden Symptoms Referable to the Heart Following Operation*) is a significant disorder of the heart beat in fact the most important common disorder. It is clear that it does not in itself contraindicate surgery. It inevitably adds a slight risk. It indicates careful digitalization.

Discussion of the chronic cardiac as a surgical risk necessarily includes methods of preparing the patient for operations. Whether or not digitals or other heart drugs are to be used is always to be decided. This is a much discussed question and its significance is probably overemphasized but it cannot be avoided.

The use of digitals in surgery is not clearly understood.

Digitalize those with auricular fibrillation

Choice of anesthetic We have had no experience with chloroform. The easiest anesthetic for the surgical problem is very likely the best choice. Cardiacs have tolerated ether, gas, gas oxygen ethylene, local, spinal, sacral preoperative morphin scopolamin or both, in various combinations according to the judgment of the moment without clear indications for a special choice appearing. Certainly cardiac disease does not in general contraindicate inhalation anesthesia. However one instinctively chooses a local anesthesia where this is feasible from the nature of the operation and the disposition of the patient. To my mind the services of an expert anesthetist are distinctly valuable in reducing strain of operations on cardiac patients.

Nowadays preoperative routine examination has developed considerably in the endeavor to sort out the poor risk patient for special consideration. This development has been chiefly along laboratory lines. Elaborate routine laboratory examinations (such as simple blood chemistry and kidney and liver function tests) are relatively easily organized in a modern hospital. Some of them are clearly of value for example in detecting an occasional diabetes and very rarely in detecting an unsuspected kidney failure and they do this more accurately perhaps (granted skill and care on both sides) than preoperative examinations by a physician.

The 71 per cent of patients whose heart condition deserves consideration however cannot be handled by indirect examinations made by technical methods alone. From time to time one hears routine technical preoperative heart examinations suggested with a view to determining operative risk. Electrocardiograms will distinguish most of the significant disorders of the heart beat (often they fail however, to report a pulsus alternans which is always of significance). Certain myocardial changes probably of significance and not clearly distinguishable clinically, are suggested by cardiograms alone. It is true that routine electrocardiograms occasionally discover an unsuspected disorder of the beat, such as auricular flutter. They will, however, not discover congestive heart failure, for example in many

patients with angina pectoris the history alone tells the story. They cannot often even suggest whether a simple tachycardia is from neurosis, thyroid intoxication, or secondary to some serious condition. They do not in any real sense serve as a test of cardiac function. They are of definite value as an adjunct to cardiac diagnosis to a physician of experience trained in heart diseases. A truly valuable direct test of the heart's function (capacity for strain) would be highly desirable. But it seems unlikely that any such tests can be devised which will be of practical value in determining operative risk. For several years I have recorded (1) Vital capacity (2) The results of a simple cardiac function test in large groups of cardiac neuroses, possible cardiacs and true cardiacs at every visit of these patients during observation through pregnancy and puerperium. Both tests clearly have proved inadequate to separate sheep from goats. So far as determining operative risk is concerned such procedures do not fill a prominent position.

If true cardiacs in a surgical clinic are to be handled comfortably they should be considered as a special group and cared for by some one familiar with heart diseases and the response of cardiacs to surgical strain.

The chronic cardiac as a surgical risk is indeed a part of a larger problem—the relief of chronic disability from cardiovascular disease. This discussion of course only briefly considers their surgical risk. It shows however that patients with severely damaged and failing hearts can when necessary be prepared for operation and operated upon without undue risk.

In addition our experience has shown that many of the most gratifying clinical results within the surgical clinic have been among patients disabled with heart disease where disability has been immensely relieved by the surgical removal of a coincident burden. We have reported the delightful results following thyroid surgery in a large group of patients with prolonged disability from congestive heart failure associated with thyroid toxicity. There is also a small but satisfactory group steadily growing of cardiacs relieved of disability by removal of surgical burdens such as a diseased gall bladder or large pelvic tumor.

CONGESTIVE HEART FAILURE AND ANGINA PECTORIS IN SURGICAL PATIENTS

BURTON E. HAMILTON

IN the preceding discussion it has been shown that severe heart disease does not, by and large, make major surgical procedures unduly hazardous. It has also been shown that patients with severe degrees of heart failure can, when necessary, be operated with a markedly low mortality. It has not been shown that patients with severe heart disease can be operated safely without special care or with preparation merely consisting of heart stimulants.

Though sudden death can and does occur from a disordered heart, not in failure, the majority of cardiac deaths occur in more or less prolonged 'heart failure,' and avoidance of heart failure is the main object in the care of chronic cardiacs. With the advance in knowledge of hearts in the last score of years, it has become clear that hearts fail in just two ways:

- (1) Congestive heart failure
- (2) Anginal heart failure

CONGESTIVE HEART FAILURE

Congestive heart failure is a failure of the heart to pump along the blood so fast as it is fed to it from the veins. The symptoms and signs are associable with the consequent venous engorgement.

Systemic Veins—General engorgement of the systemic veins occurs in congestive failure, but this is only easily demonstrable by a few signs, namely, engorged neck veins with the patient relaxed and head and neck elevated so that the neck veins are higher than the heart. This is not always clearly demonstrable in failure, and may be caused by other conditions offering

obstruction to the flow of blood from the neck veins into the mediastinum *Engorgement of the liver* *Enlargement* which on direct examination may not always appear symmetric for example the left lobe only may be felt as an epigastric tumor which in some cases suggests a neoplasm *Tenderness* This may be absent or marked and need not vary directly with the apparent size of the liver *Pain* This rarely may be severe commonly more a sensation of fulness or pressure than pain in the epigastrium or in the right upper abdomen There is sometimes ascites (even without clear evidence of edema elsewhere) General demonstrable edema is inconstant in degree and often is not present It is usually a more or less retarded result of congestive heart failure It is not a cardinal sign *Engorgement of the pulmonary veins* shows itself by diminished vital capacity and in increasing degrees *breathlessness* which nearly always is associated with orthopnea *rales* particularly in dependent portion sometimes localized at one lung base only (Rarely *pleural effusion* which may be apparently unilateral) *Cough* which may be productive *hemoptysis* as pink stained sputum in association with a general edema of the lungs more commonly as varying amounts of fresh blood or blood flecks in sputum Though hemoptysis is usually only present in severe degrees of congestive failure particularly in mitral stenosis small amounts of clear blood may be expectorated with no other clear signs of failure present

Congestive failure may be relatively mild and chronic the patient up and about though handicapped by some or all of the above symptoms It may be severe and may be of very sudden onset It may be fleeting or persistent The degree rapidity of onset and course vary greatly Though the physical signs and the subjective symptoms from the congestion of both pulmonary and systemic veins are usually simultaneously present there may be considerable difference in the relative intensity of the signs in the two venous systems Occasional cases complain bitterly and only of some special group of symptoms

Without discussing the more clearly medical problems causing various confusions of diagnosis that are possible from

a congestion of the pulmonary veins which suggests pneumonia, phthisis, neoplasm, it is easy to see the confusion in surgical diagnosis that can result from congestive heart failure when the pulmonary symptoms are slight, or not complained of by the patient, but when upper abdominal pain and tenderness are prominent.

The danger is well known of performing an abdominal operation on a patient with upper abdominal tenderness or pain caused by a liver congested by heart failure which wrongly suggests some surgical condition. In my experience the mistake is rarely made, but it is by no means unknown. The following case history is related for illustration:

A man aged fifty-five gave a history of congestive failure associated with hypertension for more than one year. Though orthopneic and breathless and with evident physical signs accounted for by venous congestion, he did not complain about his cough and breathlessness, but did complain bitterly of almost constant abdominal distress. His abdomen was distended, tender in the upper half, less toward the left. No mass could be felt because of resistance, but the upper left and center were dull to percussion. There was no general edema. The heart was regular and not very rapid. He had a "good pulse" with hypertension, but a pulsus alternans. He had appendectomy eight months before entrance to this clinic, without relief, and three months before entrance his gall-bladder was removed, without relief. His persistent congestive failure increased and he died (three weeks after entrance) from this alone. General edema did not appear until a few days before death.

Both the patient and his family were convinced that the trouble was from some abdominal condition. I can well understand that it would be easy to be led into an abdominal operation in this case by the patient's pleadings if the signs of failure were not very clear. Many single case histories could be given where at any rate for a time the diagnosis of congestive failure presented marked difficulties in surgical diagnoses even when this particular point was fully appreciated.

It is theoretically possible for a patient with congestive heart failure to have coincidently an acute abdominal condition.

the chances are against it. In my experience, where this honest doubt has arisen, *no mistakes have been made by postponing operation*. With one possible exception the cases that I have seen have proved not to have any complicating acute surgical abdominal condition. In a few cases operated the abdominal signs have been so misleading that abdominal section was performed in full knowledge of the failure and nothing was found but the congestion.

Though the patient described survived his operations it is not always safe to disregard a congestive failure and operate.

An elderly woman wished a small wen removed because of unsightliness. She was sent to hospital elsewhere and the wen was readily removed. After operation it was noted that her heart was irregular and cardiologic examination showed slight orthopnea, rales at the bases of both lungs, slightly enlarged liver, a large heart, rate around 120, pulse count 90, irregular, but not too obviously so to escape notice at casual examination. She had clearly auricular fibrillation and congestive heart failure. The patient fairly enough was given digitalis. The next day she had an embolus to a leg resulting in a gangrenous condition; the patient became desperately sick; amputation was indicated and performed but the patient did not survive. This unusual case illustrates what a chain of misfortunes may occur in patients with auricular fibrillation, with congestive failure. The original operation perhaps in no way caused death but the sequence of unhappy events terminating fatally happened to occur after the patient went to hospital and was operated upon. Briefly thrombi may form in the left auricle, for example in heart failure. They probably form more easily where auricular fibrillation is also present and no doubt still more frequently when also the mitral valve is stenosed. The thrombi may become emboli. Such emboli cannot of course be predicted but there is a tendency for them to occur during or shortly after a congestive failure. When failure can be relieved it is well to wait for three weeks of rest in bed before allowing a patient exertion (or in the connection now discussed) to consider operating upon them. It is possible for intracardiac thrombi to

become adherent to the endocardium, for them to become at all firmly adherent, I am told by pathologists, takes at least three weeks. Clinically, whether or not it actually prevents some emboli, the practice of delaying an operation for three weeks after relief of congestive heart failure appears to have been at any rate associated with a highly satisfactory mortality in such cases in my experience. Also, making this rule inflexible undoubtedly has caused us to give a long and generally beneficial rest in bed to patients who have been quickly relieved of their gross signs of heart failure, in spite of the temptation of the arguments of patients and our own natural desire to have the operation over quickly.

A woman aged forty, with a history of rheumatic fever in girlhood was admitted with mild congestive heart failure of several weeks' duration. The heart showed mitral stenosis, the rhythm was regular. The failure cleared within forty eight hours. Later it was incidentally found that she had had severe dysmenorrhea for several years. Rectal examination suggested a large pelvic tumor. The patient was obviously in good condition a few days after entrance, but was rested for three weeks because of her congestive failure at entrance before either examination and operation, if indicated, was attempted. Two and one half weeks after entrance she had an unexpected attack of auricular fibrillation with rapid ventricular rate and return of congestive failure. The failure cleared after slowing of the ventricular rate with digitalis, but operation was again postponed for at least another three weeks after this failure. Two weeks after the second failure cleared, embolism occurred, simultaneously blocking both femorals. The emboli were promptly removed surgically, but the patient died in twenty four hours. Necropsy showed other emboli in particular one occluding the mesenteric artery which appeared as the most prominent cause of death. This case emphasizes from one point of view the advisability of at least three weeks of complete rest after a congestive failure. If an operation had been performed before either sudden event, and since the patient appeared in good condition at both these times, operation would have been done but for the

rule of three weeks rest after a failure it would have appeared to us and all concerned that the events over which we had no control and the deaths were at any rate in part excited by the operation

Altogether 144 patients under my personal supervision have had gross congestive failure at entrance to hospital and have later had major surgical operations 8 operative deaths Many of the above cases were actually in failure at the time of operation a large portion of these had thyroid toxicity and their failure could not be relieved by any means before operation the remainder were obstetric patients in circumstances which forced abdominal sections even though the patients were in severe degrees of failure The results have been surprisingly good but in emphasizing the fact that our experience has shown that patients with severely damaged hearts with auricular fibrillation and even those who have had failure and even those that still have it if need be can be operated with surprising safety it should be emphasized that

- 1 Every effort to relieve failure has first been made

- 2 A prolonged preparatory rest in bed has followed relief of failure before operation

- 3 Those with failure persisting after all reasonable efforts have been operated on only when the most favorable time appeared

As a rule the most unpromising risks at entrance when carefully prepared and when operation has been patiently delayed for the most favorable moment have survived major surgery with great ease when the test came

A recently operated case illustrates this Mrs C aged sixty-six years had been increasingly breathless on moderate exertion for several years and for five weeks orthopneic She had been in bed for at least a week before entrance but in spite of this still showed orthopnea rales in lung bases respiration hurried and shallow neck veins prominent the liver was engorged and tender and the abdomen distended She had edema of the legs and feet The heart was grossly enlarged and moved the chest wall forcefully with each beat there was a loud systolic murmur the rate was rapid and rhythm regular but every alter

nate beat was weaker than the others by about 10 mm. of mercury in the radial systolic pressure. She was feeble, apprehensive, nauseated, sleepless. The signs of failure persisted for two weeks. Three weeks later the patient was comfortable, reassured, sleeping well, but, of course, still in bed and spared every possible exertion, even being fed by her nurse. She survived a subtotal thyroidectomy (adenomatous goiter) without appreciable reaction. Several weeks later the patient was prepared for operation for a large fibroid of the uterus. The morning of operation she felt nauseated, and vomited once. She gave a history of occasional nausea and vomiting attacks associated with some upper abdominal discomfort, usually on the left. The patient vomited several times during one day, then continued in good condition, and three weeks later survived removal of the uterus and of a large gall-bladder filled with stones. She had an uninterrupted recovery unusually free from discomfort. Why operate on such a patient? Removal of these heavy burdens from a severely handicapped cardiac patient in this case, as in many others, resulted in a definite improvement in ability.

Heart failure of the congestive type does not follow surgical strain unless previously present. It is only found in cases with coincidentally badly damaged hearts, and even among patients with badly damaged hearts, but not in failure at the time of operation it is extremely rare for congestive failure to appear as a result of operation. This should be valued as showing the operability of chronic cardiac patients, but, as shown in this and the preceding discussion, it should not justify a general disregard of the heart condition in surgery.

An understanding of heart failure is of importance to a surgeon for the following reasons:

1. To aid in avoiding operating on supposed surgical abdominal conditions that are really more or less obscure heart failure, either "congestive" or "anginal."

2. To avoid precipitate operation on patients in unsuspected serious heart condition which may be improved by intelligent preparation.

3 Most important of the three To avoid refusing needed operation to patients because of an apparent cardiac compensation which does not exist but is merely a cardiac neurosis or because of a real failure which when properly handled permits reasonably safe operation with no more risk than would cheerfully be accepted by all concerned

ANGINAL FAILURE

Among the middle aged or older patients in a surgical clinic a small number are limited beyond a more or less fixed point in all forms of effort by discomfort constriction or fulness or pain described at times as soreness aching burning sensation located substernally or close to the epigastrium to right left or both radiating or not to neck throat jaws arm or arms rarely radiating to the back or downward The sensation is produced by effort or excitement and is relieved promptly by rest It is usually relieved also quickly by vasodilators such as nitroglycerin

This group of patients is much smaller in my experience in a surgical clinic than the group with congestive heart failure Approximately 12 cases that I have personally examined have had major surgical operation (not including nose and throat and oral operations) there have been no deaths

As is well known a number of clinics have reported small series of patients of this type who have had surgical removal of some of the cervical sympathetic ganglia in an effort to relieve angina The majority have survived operation

General treatment of patients with this chronic anginal failure consists principally in a removal of burdens such as limiting exertion rest after meals weight reduction and so forth A search of such patients for surgically removable burdens is clearly indicated In my short series of cases with chronic angina pectoris who have had a significant surgically removable burden the patients have stood surgical strain without alarming developments and a few who had toxic adenomata of the thyroid have shown definite amelioration of their disability following the removal of the burden

A very striking example is a man of sixty five with chronic angina for six years, and an attack suggesting a coronary occlusion with recovery nine months before operation. During the seven months before operation there was increasing nervous irritability and a weight loss of 40 pounds. Though up and about effort beyond slow walking about for short distances was stopped by angina. The patient had had an adenoma of the thyroid the size of a hen's egg for many years. Although he had consulted excellent medical opinion it was considered that the adenoma was not a factor in his health until his general practitioner became suspicious. The patient proved to have a basal metabolism ranging from +38 to +52. Following one week's observation in hospital the adenoma was removed under local anesthesia. He had an average reaction to operation shown in slight elevation of pulse temperature and respiration, with moderate increase of the usual nervous irritability for thirty six hours and made an uninterrupted recovery. There was no complaint of angina at this time. He has been able to extend his activity enough to resume his regular business and since operation has not felt angina.

Such easy opportunities to remove heavy burdens from patients with chronic angina unfortunately do not come often to an internist. We should look for them and seize them.

It is seldom that chronic angina suggests strongly a surgical condition. An occasional patient with gall stones will have pain radiating to the regions more characteristically invaded by angina pectoris. But observation for a reasonable time nearly always will clear the confusion because of the essential dependence of the symptoms of chronic angina on exertion. Not too uncommonly the same individual will have coincidently a chronic angina pectoris and gall stones.

Within the last few years it has become general knowledge that *coronary occlusion* as a sudden clinical event can often be recognized. And it is well known that this disorder can often confusingly suggest an acute surgical condition of the upper abdomen. The general subject of the diagnosis and prognosis of coronary occlusion has naturally been the subject of a very

large number of articles in the last twenty years. I will deal with it briefly, from my own experience, only so far as it seems to me to concern surgeons.

It is a possibility to consider in diagnosis of surgical conditions of the upper abdomen.

Simple Points in Diagnosis—It occurs in middle aged or elderly people, those who previously have had "chronic" angina, or in patients without previous disability. In a series of 100 consecutive cases with chronic angina or coronary occlusion or both that I have personally studied the average age was sixty-one, the youngest thirty-seven, there is no upper age limit, 74 were men.

The angina may differ in degree from mild to very severe requiring stupefaction of the patients by sedatives for any appreciable relief. It is felt most commonly in the epigastrium or under the lower end of the sternum, and may radiate to or center in the regions previously described for "chronic angina." It occurs independently of previous exertion and typically is not promptly relieved by rest and is little affected by vasodilators.

There is the general picture of shock which differs in individual cases from very mild to extreme. There may be nausea and vomiting. Anxiety is common, but is often absent in those having mild angina. The angina may persist indefinitely, or may improve and disappear after hours or days, perhaps to return after hours or days.

If the patient is seen near the onset of the attack there is seldom anything about the examination of the heart to help the diagnosis. The decision is made in the absence of a clear surgical abdomen, in the presence of a patient old enough to have a coronary occlusion, and in the presence of angina.

The blood pressure tends to be low but in rare cases a hypertension will persist through coronary infarction. The heart rate also, though often quickened to above 100, may remain slow.

Hours or days later any or none of the following signs may develop: Pericardial rub, extrasystoles, paroxysmal tachycardia, dropped beats, a new systolic murmur, changing heart sounds,

faintness particularly of the first sound gallop sounds, embolism pulsus alternans Heart failure of the congestive type may develop Some irregular fever is common and moderate elevation of the white blood count is the rule during the first weeks of a coronary occlusion

A single electrocardiogram taken during an infarction from a coronary occlusion often is not helpful It sometimes adds evidence If compared with previous tracings or if repeated during the progress of the infarction it may be diagnostic

It is most important to realize that none of the physical signs and laboratory findings are constant and that any rule may fail There is no reliable simple rule for diagnosis A clear cut case is certainly as easy to diagnose (after experience and with the possibility in mind) as a case of gall stone colic The less clear cases are often extremely unsatisfactory to diagnose and occasional errors are actually to be expected Early diagnosis particularly frequently has to be made on very scanty findings Unlike confusing situations presented by congestive heart failure in surgical diagnosis confusing situations when coronary occlusion may be suspected often do not permit of a safe decision to delay operation

In such a situation a knowledge of the actual clinical diagnosis of the various acute upper abdominal disorders must be consciously weighed against the actual clinical diagnosis of coronary infarction and a decision made *without* waiting developments

Case I—An apparently healthy and robust man of sixty nine leading an active business life following a customary round of golf ate a heavy luncheon and immediately felt a dull pain in the epigastrium enough to decide him to walk home instead of playing more golf in the afternoon He vomited once, a portion of his luncheon pain was not severe but unpleasant He called his physician who ordered an enema which was followed by some relief He had a comfortable night and was up and about in the morning feeling nearly as well as ever, and stayed quietly around his home all day in comfort The next

morning the pain returned but not severely. His physician, a very careful man, drove him to a hospital for x ray examination in particular for suspected gall bladder disease. The examination was negative. Consultation with an experienced and able surgeon resulted in an opinion of nothing surgical. He returned to his home. Five days after the onset the patient was comfortable nearly all the time but more or less conscious of a sense of pressure in the epigastrium. The sense of pressure moved upward under the sternum. It was not referred elsewhere. He tolerated a light diet well, his bowels moved regularly, he had a slight fever and a white count of 15 000. His physician discussed the case with an internist who suggested the possibility of coronary occlusion. During the eighth night the substernal discomfort became severe and required morphin. He was seen by me on the ninth day. He appeared moderately pale and anxious. His heart was regular with an occasional extra beat noted for the first time; there was a loud systolic murmur said by his physician to be a new development. There were no signs of congestive heart failure. Heart rate 102. Blood pressure 130/100 in both arms.

Diagnosis—Coronary infarction.

Prognosis—About an even chance of being alive in three weeks.

Treatment—Absolute rest in bed, night and day nurses, lightest diet, sedatives, no stimulants.

The patient was comfortable until toward the next morning the pain became aggravated, the heart showed very frequent extrasystoles and short runs of extrasystoles. The following day there was a sudden pain in the right leg; the veins of the lower leg became congested, no arterial pulsation could be made out in the popliteal artery or its branches, and a few hours later a similar condition appeared in the left leg. The patient sank into a state of shock and died about thirty six hours later, eleven days after the original complaint of epigastric distress following a heavy luncheon.

This is a rather typical case of coronary occlusion. It is easy to diagnose after the evidence is in. Though such cases are

very common, and the diagnosis of a possible surgical abdominal condition is often considered before the heart is thought of as a cause, I believe very few such cases are mistakenly operated upon

The following case is clearly unusual

Case II—A clergyman, robust and active, had many attacks of typical gall stone colic. x Ray examination showed gall stones. He declined operation and was free of pain for several months. During this time he went gunning, climbed hills and played golf without discomfort. A sudden attack of epigastric pain and vomiting confined him to bed for one day when the pain improved but persisted for several days as a nagging discomfort, so that he decided to be operated. He was operated and a gall bladder containing many stones was removed. He had fever for the first four days only, and had an uninterrupted recovery until the fourteenth day, when he complained of severe substernal pain. He was then found to have a loud systolic murmur and extrasystoles. The following day he had a pericardial rub. He sank into a state of shock and died on the seventeenth day after operation, about three weeks after his original "gall bladder" pain.

Autopsy showed an infarction in the left ventricular wall involving a large area. the pericardium was adherent over this area and there were large thrombi within the ventricle partly adherent to the wall. The condition must have antedated the operation.

Somewhat similarly, a coronary occlusion occurring by chance during or following a surgical operation is by no means unknown. This situation is apt to be overlooked.

A coronary occlusion with sudden violent symptoms suggesting an acute surgical emergency is not unusual. Following is a case which further illustrates the confusing possibilities of this condition.

A man aged forty five with a vague history of upper abdominal discomfort of several months duration relieved by alkalis, suddenly complained of violent and persistent epigastric pain,

requiring $\frac{3}{4}$ grain of morphin in a few hours with little relief. He had a rapid pulse a temperature of 100° F and a fear of impending death. A consulting surgeon operated upon him as a surgical emergency. There was nothing found in the abdomen except a moderate amount of free fluid. The liver appeared somewhat enlarged. The gall bladder was drained but the surgeon felt that he had operated upon a patient with a coronary occlusion. He was seen by me twenty four hours after operation in a dying condition. he was delirious the temperature was 104° F the heart rate 140 he was pulseless. There were râles at the lung bases. Though there was little clear evidence for this it appeared to me particularly in view of the negative abdomen at operation the large liver found the râles at the lung bases that the patient had had a gross coronary occlusion and now had congestive heart failure. Autopsy showed a very severe acute pancreatitis and a normal heart.

Though the above case was not saved by operation it seems to me important to realize in a similar situation

- 1 That a diagnosis of coronary occlusion offers a not very cheerful prospect to patient or physician. The patient has a good chance to survive but this probably depends largely on conditions that are entirely beyond control and will not be much lessened by an operation. Though it is a deplorable thing to operate thoughtlessly on a patient with coronary disease an occasional coronary occlusion or acute pancreatitis presents a picture that is actually undiagnosable.

- 2 A missed diagnosis of acute pancreatitis or ruptured gastric or duodenal ulcer may directly result in the patient's death. proper diagnosis and operation may save life and return him to full ability.

THE TREATMENT OF EMBOLI IN THE PERIPHERAL VESSELS

FRANK H. LAHEA

THE publication by Key¹ of the results of his experience with embolectomy demonstrated the possibilities of conserving by this procedure extremities which would otherwise be lost.

Key in this publication reported 45 cases 13 of which he states had a happy outcome.

To the above record Soderlund² added 17 cases making 62 cases in the literature with good results in no less than 24 over one third of the cases.

We have performed embolectomy three times in this clinic upon 2 cases of femoral occlusion one bilateral all of which died later of multiple or further emboli. The experience however with this operation has convinced us of the soundness of the procedure and we believe will enable us to preserve some extremities also.

The details of 4 cases are presented together with certain remarks concerning emboli and embolectomy gained from those cases and from a review of the literature on this subject.

All cases reported in the Scandinavian literature have been operated upon with local anesthesia. This seems essential not only because the patients upon whom this operation is done are poor risk cases but also because general anesthesia possibly predisposes to other emboli.

The diagnosis of the lodgment of an embolus in an extremity has not been difficult. The sudden pain the change in color (blanching) of the extremity the loss of pulsation in the vessel distal to the embolus and the ability to demonstrate the point

¹ Acta Chirurgica Scandinavica vol. 54 1922

² Ibid. vol. 59 Fasc. III 30 vi 1925

at which pulsation of the artery ceases makes the demonstration of its existence and location fairly simple. The diagnosis is also often made easier by the fact that these patients suffer from diseases prone to produce emboli such as cardiac failure, valvular disease, etc., as in our cases.

The most common points at which emboli lodge are at the division of a vessel, as at the bifurcation of the aorta, at the profunda branch in the popliteal and in the axillary, where the subscapular is given off.

When an embolus is located at the division of the aorta, common iliacs, common femoral, popliteal and axillary arteries and sometimes upper brachial, the danger of gangrene is grave.

Regarding brachial embolism, Gustaf Soderlund¹ who reports 2 cases of embolectomy, one of the popliteal and one of the brachial, states that emboli in the brachial are much less liable to produce gangrene than the popliteal, but that it has been his experience that even if gangrene does not occur, there is great disability from loss of functional power in the hand.

The danger of secondary thrombus formation increases with the time elapsed after the embolus has occurred. Key has seen beginning secondary thrombus formation two hours after embolus and again has not seen it in late cases.

Exposure of the vessel shows the location of the occluding clot very clearly. Pulsation will be seen to cease at the upper most limit of the clot and the vessel from the upper level of the clot downward is of distinctly smaller caliber. Palpation demonstrates the solid cord like consistency of the clot filled vessel.

A large number of the reported cases have been operated upon from one and a half to five hours after the lodgment of the embolus. Our cases were operated two and a half, four hours and forty five minutes respectively after occurrence of the embolus. Cases are reported however which were operated upon much later, one four and a half days after and of course unsuccessfully. It is stated that in no case is embolectomy successful when done twenty four hours after the occurrence of the embolus.

¹ Acta Chirurgica Scandinavica, vol. 59, Fasc. III, 30, v. 1925.

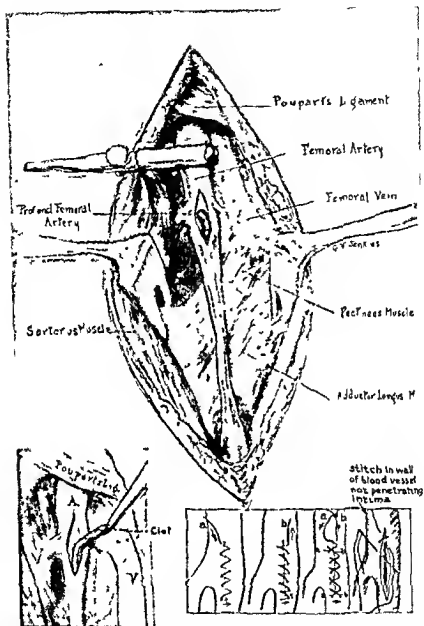


Fig 224—Showing exposure of vessel The incision in the vessel and application of the clamp Inserts showing removal of the clot and suture of the vessel

The removal is begun by first applying a rubber-covered vessel clamp to the vessel sufficiently far above the upper limit of the embolus so that there may be adequate room for the arteriotomy

An incision 1 cm. in length is then made in the artery just at the upper level of the embolus and the embolus extracted both by pulling gently with a pair of forceps from above and milking upward by gentle pressure on the vessel walls from below.

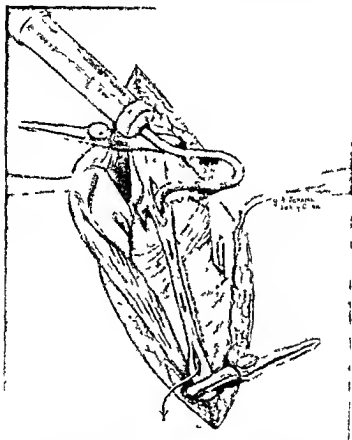


Fig. 22b.—Showing incision also below clot a method of irrigating through vessel with citrate solution. Note clamp applied below to prevent clot escaping into vessel below.

At times it was not possible in our cases to extract the embolus by this means. In such cases uterine sounds, small blunt curets and small gall stone scoops have been employed to loosen them. Before such measures are employed however,

it is wise to place a vessel clamp below the lower level of the embolus and to do another arteriotomy at this level to permit the escape and to prevent pushing the fragments further downward in the lumen of the artery. If fragmentation of the embolus occurs, a syringe and catheter may be employed to wash the lumen free of fragments with 2 per cent sodium citrate solution. Following the removal of all of the embolus, including any of its fragments, the upper arteriotomy wound is closed, the upper clamp loosened and blood allowed to rush through the sutured and previously plugged portion of the vessel, thus serving to remove any remaining clots from the lumen and to demonstrate its patency. The clamp is again closed and the lower arteriotomy wound then sutured.

In this connection it is well to have in mind the advice of Key regarding the treatment of an embolus lodged at the bifurcation of the aorta. He states that since the condition of those patients will not permit the exposure of the aorta at its point of division and removal of the clot by direct embolectomy, it is better to expose the femoral and attempt to dislodge the clot by means of a uterine sound or blunt curet, a method which is much more rapid, less shocking, and possible to perform under local anesthesia. It is obvious however, as he states, that the opposite femoral must be exposed and obstructed by a vessel clamp in order that the loosened fragments of the embolus may not descend into the femoral of that side. Following loosening of the embolus an arteriotomy must also be done on this side just above the level of the clamp to let any fragments of the broken up embolus which have come down be worked out by the blood stream, a clamp being placed above to shut the stream off when the clots are cut and so that the arteriotomy wound may be sutured.

Attention is called to Key's statement emphasizing the possibility of multiple emboli and that small emboli which have gone farther down than the main embolus may cause postoperative disturbances. We believe, as has been suggested, that many incisions in vessels are made too short, due to the fear of operators that clotting will occur along the suture line. Too

small incisions result in unnecessary trauma to the vessels in forcing out the clots resulting in a greater likelihood of clotting as a result of this than from the suture line of an adequate incision.

At least one writer¹ on this subject advises that intervention be attempted even in cases where gangrene has set in as thereby an improvement in circulatory conditions may be secured. This he writes is proved by 5 cases in the literature.

This same author urges that arteriosclerosis is no contra-indication at least for an operative exposure of the artery and that if the condition of the arterial wall renders arteriotomy impossible an attempt should be made to crush the embolus after the method of Abadie and Mathelin.

While we have had no experience with embolectomy on an artery the wall of which was too sclerotic for operation we have had 1 case in which the embolus was undoubtedly broken up or loosened by digital manipulation.

Case I—Mrs E. B. aged sixty eight years. Patient was operated upon four years ago for a toxic goiter. She made a splendid recovery following the operation and considered herself well until her present admission when she complained of sharp pain in the right upper quadrant. After investigation a diagnosis of cholelithiasis was made. Cholecystectomy with choledochostomy was performed. During convalescence from the gall bladder operation she had several attacks of pain with fever the pain being in the region of the right kidney. The urine was loaded with pus. Pyelograms showed a large right hydronephrosis. At operation the right kidney was found to be almost completely destroyed. Nephrectomy was done. On the morning of the tenth day following this operation patient was seized with severe pain in her left thigh which soon extended to include the whole lower leg. A neighboring patient massaged the thigh vigorously with improvement in the pain in the region of the thigh but patient stated that the pain in the lower leg became rather more intense. Patient was seen shortly after the

¹Eric Michaelsson. En Fall von Geglückter Embolectomie. Acta Chir. urg. Scand. na. ca. vol. 56. 1924 p. 438.

leg had been massaged and there was good pulsation of the femoral artery as felt in Scarpa's triangle. The popliteal artery could not be felt nor could the dorsalis pedis or posterior tibial arteries. The entire foot and lower leg was of a peculiar waxy color, to touch the foot was distinctly less warm than the opposite member. A pin prick of the great toe bled distinctly less than a similar puncture of the opposite foot. The pain in the lower leg was excruciating. One half hour later patient was seen in consultation with Dr. Hamilton. The pain by this time had subsided to a considerable degree, other signs still were present. Diagnosis of embolus, probably in a branch of the popliteal artery or one of its branches was made. In view of the fact that the pain seemed to be subsiding and that the embolus was probably low down in the popliteal or in one of its branches, expectant treatment was decided upon.

During the subsequent week the foot continued to be exceedingly painful. There was no pulsation in the popliteal or dorsalis pedis arteries. The foot was cold to touch. The fourth toe became discolored in its distal portion and there was a purplish mottling around the heel. Aside from the foot the lower leg did not show any abnormality. Berger board treatments were started as well as daily treatments with the Quartz lamp. Within three weeks all the discolored area had disappeared. There was no pulsation to be felt in the arteries and the pain continued. During the following month the treatments with the Berger board and quartz lamp were continued with slow but progressive improvement.

At discharge there was no discoloration of the foot whatever and there was a question of pulsation in the dorsalis pedis artery, some observers believing they felt it others not.

Comment — In this case the patient as far as we know, had no pre-existing heart disorder. Her peripheral vessels showed well marked sclerosis. Her pulse had been regular at all times and there were no signs of congestive failure. Expectant treatment was decided upon because the location of the embolus seemed to be in one of the branches of the popliteal in which case it did not seem practical to attempt an embolectomy.

From her history it would seem that the embolus first lodged in the femoral artery and was forced downward into one of the smaller branches of the lower leg by the vigorous massage received at the hands of a neighboring patient

Case II—Mrs E C, aged fifty six years Entered hospital complaining of fatigability, breathlessness, and orthopnea Symptoms had become progressively more severe for several years There had been no rheumatic infection or significant diseases The heart was enlarged the rate was 140, absolutely irregular There was a suggestion of mitral diastolic murmur The liver edge was palpable but not tender There was slight edema of the extremities The signs of failure largely occurred *forty eight hours after entrance*

Ten days after signs of failure had cleared patient was seized with a sudden sharp pain just above the right knee When seen a few minutes later the whole lower leg was of diminished warmth and wax like in color Just above the knee, extending upward for about 4 inches the skin was of a mottled reddish purple color The femoral artery could be felt pulsating for about 2 cm below Poupart's ligament Below this it could not be felt No pulsation could be felt in the popliteal arteries or in the posterior tibial or dorsalis pedis A diagnosis of embolus in the femoral artery was made and operation begun two and a half hours after the first symptoms had been noted

Operation (Dr Lahey, Dr Mason assistant, Dr Sise, anesthetist)—Under spinal anesthesia an incision 8 cm in length was made in the left thigh over the femoral vessels The femoral artery was exposed from Poupart's ligament downward for about 10 cm There was vigorous pulsation in the upper portion of the exposed artery for about 4 cm below Poupart's ligament Below this point for about 8 cm the vessel was of a cord like consistency and markedly diminished in caliber The profunda femoris was of a like consistency and without pulsation The pulsation of the artery from above caused a distinct downward thrust on the occluded portion A vessel clamp was applied about 1 cm above the point of cessation of pulsation Another

clamp was applied about 1 cm. below the occluded portion. An incision 1 cm. in length was then made in the artery with its upper level just above the point of occlusion. Upon opening the artery at this point the clot extruded. By gentle traction a portion of the clot 2 cm. in length was removed. The point of emergence of the profunda femoris was investigated and its lumen found occluded by a clot. This was also removed by gentle traction. The arteriotomy was then closed by a layer of oiled silk sutures. Before removing the clamps another arteriotomy was done just above the lower clamp. Investigation of the artery at this point showed no clot. The upper clamp was then loosened and blood emerged from the lower incision with a brisk spurt. This was done in order to wash out any remaining small particles of clot. The upper clamp was again tightened and the lower arteriotomy closed in a similar manner as the first. Both clamps were then removed. Immediately following the removal of the clamps there was no pulsation in the artery. Warm saline compresses were applied. Within a very short time pulsation could be distinctly felt throughout the length of the exposed artery. An observer reported a feeble pulsation in popliteal artery, but the color of the foot remained unchanged. After closure of the incision in the thigh the leg was carefully wrapped from toes to groin with cotton.

Diagnosis.—Embolus of the right femoral artery.

Operation.—Embolectomy.

A few hours after operation this patient complained of pain in her right arm. Her hand and forearm became snowy white in color and radial pulse could not be felt. The following day she had a moderate convulsion with evidence of a cerebral embolus. These convulsions recurred several times through the day. She was wildly excited and delirious and there was still no evidence of pulse in the right arm or in her right leg. She became unconscious, failed rapidly, and died suddenly twenty-four hours following operation.

Comment.—This patient undoubtedly had an ulcerative endocarditis with multiple emboli, which apparently continued after operation. Autopsy refused.

Case III—A F aged forty years was admitted to the Cardiac Service under Dr. Hamilton complaining of orthopnea and breathlessness of several years duration. There had been no rheumatic infections or other significant illnesses in her past history.

Physical examination showed a heart grossly enlarged; the apex was easily felt in the midaxilla; the ribs and sternum moved with the heart beat; the apical first sound was loud and long. There was a mitral diastolic murmur. The rhythm was regular except for a slight suggestion of alternation. The rate was 120; blood pressure 124/90. There was slight fulness in the region of the liver though the edge could not be felt. There were no masses or tenderness. The patient responded at once to rest and diet. Her orthopnea completely disappeared; her lungs had cleared; the liver fulness had gone; and the heart rate had become slow within twenty-four hours.

After about ten days the patient suddenly developed an absolutely irregular heart rate—auricular fibrillation. There was no history of previous attacks. The signs of congestive failure returned at once. The liver edge was palpable at least three fingerbreadths below the costal region and rales in the lungs were numerous. With digitalization the heart rate returned in about twenty-four hours to normal limits with relief of the congestive failure; but the auricular fibrillation returned within the next twenty-four hours and persisted in spite of the continued digitalis. The signs of failure did not return.

Two and a half weeks after the signs of congestive failure had disappeared during the afternoon of the twentieth day in the hospital patient suddenly complained of a knife-like pain just above the right knee. Within a very few moments she complained of a similar pain in the left knee. On examination both lower legs were cold to touch and of a wax-like color except for an area extending upward from the knee for about 3 inches which was of a mottled purplish color. She was able to flex each knee slightly but this was accompanied by excruciating pain throughout the legs. On both sides the femoral arteries could be felt pulsating for about two fingerbreadths below

Poupart's ligament The pulsation was somewhat stronger on the left side. There was no pulsation felt in the popliteal, dorsal, pedis, or posterior tibial arteries. It was decided that she had a simultaneous occlusion of the femoral arteries probably at the point of origin of the profunda femoris.

Operation (Dr. Lahey, Dr. Mason, assistant, Dr. Sise, anesthesiologist) —Incision 10 cm. in length in right thigh over femoral vessels. Femoral artery exposed from Poupart's ligament downward for a distance of about 10 cm. Pulsation was absent below the level of the profunda femoris. Vessel clamps were applied well above this level and at the lower end of the exposed artery. An incision was then made in the artery about 1 cm. above the lower clamp. This exposed the clot in the lumen of the artery. By milking the artery from above a clot about 4 cm. in length was expressed. The clamp at the upper end of the artery was then released, but there was no flow of blood. Accordingly the clamp was again tightened and incision made in the artery $\frac{1}{2}$ cm. below the level of the profunda femoris. Here another clot about 1 cm. in length, was found. This was expressed by milking the artery from above and by extraction with forceps. A small catheter was inserted in this incision and injected water emerged freely from the lower incision. This indicated that the lumen was free. When the upper clamp was released blood spurted freely from both incisions. All blood was washed from lumen. The incisions in the artery were then closed by fine arterial silk sutures. The upper incision was closed first, and with release of the upper clamp blood emerged from the lower incision in a brisk spurt. Clamp was again tightened and the lower incision closed in a manner similar to the first. All clamps were then released and the pulsations were felt and seen throughout the exposed length of the artery. A similar procedure was adopted in the left thigh. Here, however, the clot was plainly felt to be about 3 cm. below the level of the profunda femoris. By means of clamps and two incisions, as described above, the clot, about 4 cm. long, was expressed. After suture pulsations could be plainly seen and felt throughout the length of the exposed artery. Immediately following the operation in each

leg there was a distinct change in color of the feet and lower legs. The color changed from a waxy white to a mottled reddish blue. There was no appreciable warmth of the skin. At the end of the operation it was thought that there was pulsation in the right popliteal but none could be felt in the left. The dorsalis pedis could not be felt on either side. Patient's general condition at the end of the operation was considered fair.

Diagnosis —Bilateral femoral occlusion by emboli

Operation —Bilateral femoral embolectomy

On return from the operating room patient's condition was considered very good. On the following morning however she complained of excruciating pain in the lower abdomen and became greatly distended. From this time on she failed rapidly and died on the morning of the second day thirty six hours after operation.

Autopsy revealed a chronic ulcerative endocarditis with mitral stenosis. There was chronic passive congestion of the lungs, liver and spleen. There were multiple infarcts of spleen. There were multiple thromboses of the mesenteric and splenic vessels with secondary hemorrhage into the omentum and retroperitoneal tissues.

A careful dissection of the femoral vessels showed that on the left side complete removal of the embolus had been effected. There was no bleeding above the line of suture. On the right side the main channel of the artery was clear with no bleeding above the suture line. However there was an embolus protruding from the profundus branch.

Comment —This case was thought to be a favorable one for operation because of the definite physical signs and because there was no clinical evidence of ulcerative endocarditis as the cause of the emboli. It was thought that a single thrombus had formed behind the stenosed mitral valve during the auricular fibrillation and congestive failure and had been the source of the emboli. If this were true the emboli would not have repeated.

Case IV —A M aged forty seven years. Entered clinic complaining of nervousness and loss of weight. She had con

sidered herself well up until six months before admission. Since this time she had lost 20 pounds in weight. She had grown increasingly nervous and irritable, tired easily, and noted tachycardia.

Physical examination showed a fairly well-developed and nourished woman. The thyroid gland showed a symmetric, firm, diffuse enlargement, characteristic of the hyperplastic type. The pulse rate was 144 with a regular rhythm. There was a fine tremor of the extended fingers. A basal metabolism showed a rate of +74. A diagnosis of primary hyperthyroidism was made and operation advised. She was put on a preliminary régime of rest in bed and Lugol's solution, and after eight days her condition had improved to such an extent that it was thought time for operation. Careful examination of her heart revealed no abnormality. It was not enlarged and the rate was regular.

During the operation she ran a consistently high pulse rate with high pulse pressure, and it was deemed inadvisable to do a complete operation at that time. Accordingly, a right first-stage hemithyroidectomy was done. The procedure the patient stood very well and was returned to her room in good condition.

Her initial operative recovery was good. Twenty-four hours after the operation she developed auricular fibrillation which responded promptly to digitalis. On the evening of the third day, sixty hours following operation, the patient complained of a sudden knife-like pain just above the left knee. Within a few minutes the pain had become more diffuse and extended downward to the toes. The left lower leg when seen by the nurse at that time was blanched. When seen about fifteen minutes later the toes were wax-like in color and cold. About the ankle was a diffuse reddish blotching. No pulsation could be felt in the dorsalis pedis or in the popliteal arteries. Strong pulsation could be felt in the femoral artery just beneath Poupart's ligament. Just below the point of cessation of pulsation there was a distinct pain on pressure over the course of the artery. A diagnosis of embolus of the femoral artery was made. In view of the pulsation of the femoral artery in the vicinity of Poupart's ligament and absence of pulsation in the popliteal artery, it was thought

that the embolus was high up in the femoral probably at the point of origin of the profunda femoris. Operation was decided upon and explained to the patient, who gave her consent. Operation was begun forty five minutes after the diagnosis was made.

Operation (Dr Mason, Dr Fife, assistant Miss Weymouth anesthetist) — Under ethylene anesthesia an incision 10 cm in length was made on the anterior surface of the left thigh over the femoral vessels. The femoral artery was exposed for about 2 cm above the profunda and about 6 cm below the profunda. About 3 cm below the profunda pulsation stopped and here there was a distinct downward thrust of the artery resembling that of an artery tied in an amputation stump. The artery was not collapsed but was hard and firm and diminished in caliber. In order to free the artery to apply clamps the dissection was carried a little farther beneath the artery in order that it might be lifted up. After this had been done we were very much surprised to find that the pulsation now extended throughout the length of the exposed artery. The pulsation was felt to extend as far down as the finger could reach. An observer now reported that there was a strong pulsation in the popliteal artery. The blanching of the toes however was unchanged. The conclusion was that the embolus had been dislodged and had become engaged at a lower point. The bifurcation of the popliteal artery seemed to be the most likely place for this to have happened. Patient was turned over on her side and incision made in the popliteal side to expose the bifurcation of the popliteal artery. Here however there was seen no obstruction. It is probable that the embolus lodged in one of the small branches probably in the anterior tibial. The leg was wrapped in cotton and patient returned to the room. She was in fairly good general condition.

Diagnosis — Femoral embolus left.

The patient made a good initial operative recovery. Her pulse was intermittently irregular and she was given digitalis. The skin of the lower leg and foot continued wax like in color. No pulsation could be felt in the dorsalis pedis or posterior tibial

arteries The thigh and upper part of the leg appeared apparently normal in color and of normal warmth

On the morning of the third day the toes and the anterior surface of the foot over the instep were of a mottled or reddish color The following day her temperature, which had been normal, became elevated It rose to 102.8° F She developed a right side parotitis Her operative wounds were carefully inspected and no evidences of infection found The following day the patient was distinctly less well The middle toe on the left foot was very dark colored and gangrene was obviously beginning During the next twenty four hours the patient failed rapidly She developed a twitching of the right arm with increased reflexes on her whole right side She was irrational She went steadily down hill and died about eight days following the operation The twitching of the arm and confused mental condition possibly represented the occurrence of cerebral emboli In a case of this kind, with no evidence of endocarditis one would not expect multiple emboli

The first patient was doubtless saved an operation by the vigorous attention of her ward mate and while her extremity was saved as a method of treatment of emboli this plan of procedure could hardly be recommended except as a last resort

It is advised that the greatest gentleness be exercised in exposing and handling the vessels and that compresses soaked in 2 per cent citrate solution be packed about the vessel, that all instruments used be rinsed in this solution, and that probes and curets used to remove emboli be smeared with vaselin There is, however, an occasional comment that citrate solution in the wound has caused poor healing and should not be employed pledgets of cotton soaked in salt solution being used instead

The method of suture appears to make little difference provided the basic rules of arterial suture are adhered to, such as gentleness, fine needles, proper suture material, and respect for the vessel intima

Cases are reported in which two rows of sutures were used one for the media and one for the adventitia (two are probably

unnecessary) and cases (a majority) in which but a single row of sutures were used. Continuous and interrupted sutures have both been employed. We have had no difficulty in controlling bleeding from the wound in the vessel using a continuous stitch of vessel suture material which may be purchased in tubes. The Λ method used by us to reinforce the single continuous line of suture is shown but is only an additional precaution against leakage.

Following the introduction of vessel sutures there is a narrowing of the vessel at and below the point of sutures. The application of a sponge soaked in warm salt solution for a few moments over the vessel permits one to observe and palpate the arterial impulses being carried through and beyond the level from which the embolus was removed.

If citrate solution has been employed to wash out the vessel the wound should be irrigated with sterile water and salt solution to obviate the possibility of this solution interfering with wound healing.

The wound is closed tightly and heat continued to the extremity to lessen the effects of prolonged temperature reduction upon the tissues.

MODERN CONCEPTIONS AND MANAGEMENT OF BILIARY TRACT DISEASE

FRANK H. LAHEY

THE diagnosis of gall bladder diseases has, up to comparatively recent years been dependent very largely upon facts which were elicited from the history. Indeed, the diagnoses have been almost entirely dependent upon the history of previous attacks, particularly when patients have been seen between attacks. Although recent developments in the way of x ray and laboratory measures have proved definite aids in the diagnosis of biliary tract diseases, the history still remains a very important item in the clinical diagnosis of this condition.

Attacks of gall stone colic relieved only by hypodermics, with pain referred in a characteristic way serve to make diagnoses comparatively simple. When however gall stone colic is not referred characteristically and is not of characteristic severity, then may the diagnosis of this condition become quite uncertain.

In this connection one of the most valuable clinical factors associated with gall bladder diseases in our experience, has been residual tenderness over the gall bladder following the disappearance of the pain.

Most attacks of gall stone colic have associated with them, whether mild or severe, a certain degree of inflammatory reaction in the form of acute or subacute cholecystitis which persists in the form of tenderness over or about the gall bladder region on deep palpation even when the colic has disappeared.

We have considered, therefore, that right upper abdominal pain followed by evident tenderness is very suggestive of gall bladder lesion.

The character of the pain in gall bladder lesions, as we have seen it varies from the slightest discomfort up to the severe and excruciating colic requiring large doses of morphin. When

unnecessary) and cases (a majority) in which but a single row of sutures were used. Continuous and interrupted sutures have both been employed. We have had no difficulty in controlling bleeding from the wound in the vessels using a continuous stitch of vessel suture material which may be purchased in tubes. The X method used by us to reinforce the single continuous line of suture is shown but is only an additional precaution against leakage.

Following the introduction of vessel sutures there is a narrowing of the vessel at and below the point of sutures. The application of a sponge soaked in warm salt solution for a few moments over the vessel permits one to observe and palpate the arterial impulses being carried through and beyond the level from which the embolus was removed.

If citrate solution has been employed to wash out the vessel the wound should be irrigated with sterile water and salt solution to obviate the possibility of this solution interfering with wound healing.

The wound is closed tightly and heat continued to the extremity to lessen the effects of prolonged temperature reduction upon the tissues.

with infection results in progressive destruction of the tissue of the organs in which they reside

Persistent kidney stones mean progressive destruction of kidney parenchyma. Persistent gall stones, except in the occasional cholesterol stone which occurs without infection, means progressive replacement of the muscular walls of the gall bladder by scar tissue until its walls may be entirely composed of fibrous tissue, the contraction of which has repeatedly converted the normal sized gall bladder into one the size of a small peanut.

If it is true that gall stones indicate associated infection, then, too, there is usually associated hepatitis, pancreatitis, and perigall bladder adhesions—all of these potential factors for the production of (1) diminishing liver function, (2) diminishing pancreatic function, (3) interference with pyloric and duodenal function, and (4) possible malignancy.

We believe, therefore, that except as stated above, those occasional cases in which cholesterol stones exist without infection, there are few gall stone cases which may be ignored by their host with impunity.

The mechanism of the formation of gall stones has practically always been associated with gall bladder infection. As proposed by Naunyn, it has been believed that cholesterol was furnished by the disintegration of the gall bladder epithelium or the extrusion of myelin-like masses from its walls. It is the opinion of Aschoff more recently that it is not the epithelium of the bile passages and the gall bladder that furnish the cholesterol, but principally the liver cells which secrete it, and it is present in the blood without disintegrating in the process. Aschoff gives us proof of this premise in the effect of artificial cholesterol feeding on a rabbit. A normal rabbit's bile contains practically no cholesterol, but if cholesterol feeding is carried out, so that the cholesterol content of the blood is increased, cholesterol is excreted by the liver into the bile. It is held by Aschoff that the cholesterol forming the nuclei of gall stones therefore is not provided by the gall bladder or bile passages itself, but is provided by the precipitation of the cholesterol dissolved in the bile. In fact, Dewey has been able by feeding cholesterol to the rabbit,

to bring about so marked an excretion of cholesterol by the liver and bile passages that small cholesterol stones were formed.

In Aschoff's lectures on pathology, under the heading "Origin of Gall stones," he has described two types of gall stones (1) "The pure cholesterol gall stone, which may occur without symptoms in a gall bladder with normal walls and may exist in this state for a long period of time and (2) as the result of migration of organisms, or obstruction to the outlet, infection may be superimposed and inflammatory gall stone disease result. Under the influence of inflammatory exudate of the mucous membrane, which is rich in calcium, and of the infectious decomposition of the bile, there occurs precipitation of pigment, calcium masses around the nucleus of the cholesterol stone, and thus originates the so called combination stone, from a nucleus of pure cholesterol not of inflammatory origin."

It is evident, therefore, that there are in gall bladders two types of stone (1) The silent stone, perhaps occurring for a considerable period of time without associated inflammation, and (2) superimposed combination stones the result of inflammation.

Even though these cholesterol stones may exist without infection, Aschoff himself still does not consider them harmless. He states "I have repeatedly pointed out that these stones through occasional impaction, or overreflex influence of the sphincter system of the extra hepatic bile passages, favor infection of the latter, especially of the gall bladder, and may become dangerous for the bearer."

The further experiments by Rous and McMaster, proving the concentrating effect of the gall bladder upon its bile, together with those of Aschoff indicate that gall stones are incidental to this process. It has been proved at operations that many gall stones originate all at one time, or nearly so, and are the result of precipitation, plus, in certain cases, a combination of calcium and proteins in the presence of infection.

Jaundice is often thought of as one of the associated diagnostic features in connection with biliary tract disease. One must recall however, that it occurs in but a very small percentage of cases of gall bladder diseases, and that, again, a very

definite number of cases of common duct stones exist for long periods of time without the appearance of jaundice.

An attack of colicky pain in the right upper quadrant which disappears, and is then followed by jaundice, is suspicious of this condition. Several attacks of pain in the right upper quadrant, each of which is followed by an attack of jaundice, should make one quite certain of the existence of common duct stones, and when an attack of pain in the right upper quadrant is followed by jaundice plus chills, this sequence of events is almost diagnostic of common duct stones with superimposed cholangitis.

The subject of jaundice in recent years has undergone many modifications from the older concepts of its cause and origin. The older ideas as to jaundice were based largely on the conception that jaundice was almost entirely an obstructive process, that the bile was manufactured by the polygonal cells of the liver, and that obstruction, either in the form of malignancy, stones in the ducts, plugs of mucus, or inflammatory exudates, resulted in biliary back pressure and delivery of the bile pigment into the blood-stream.

Due to the work of Aschoff, McNee, and others, particularly Aschoff's description of the reticulo-endothelial system, a considerable modification of this explanation of jaundice has resulted.

It has been demonstrated that there are certain cells of marked phagocytic activity lining the blood sinuses of the bone-marrow, the serous cavities and the so-called "Kupfer" cells lining the venous capillaries of the liver, which have the ability to take up large quantities of cellular debris and hemoglobin, and, in all probability, to convert them into bilirubin. It is believed by Aschoff and his co-workers that the stellate cells of the liver, called the Kupfer cells, convert the hemoglobin into bilirubin, and that it is excreted by the parenchymal cells of the liver rather than that it is manufactured by the parenchymal cells of the liver, as was the previous conception, based on the work of Minkowski and Naunyn. Proof of this conception is evidenced by the experiments of Mann, who demonstrated that bile may still be present in the blood even after removal of the liver. There are numerous experiments to demonstrate the

probable correctness of Aschoff's theory that the actual production of bile itself is not associated with the liver cells such as those of Whipple and Hooper in which hemoglobin was delivered into the circulation when the circulation was so arranged that it was limited to the head and thorax only and still bile was developed. This explains readily then the jaundice of hematogenous origin associated with certain splenic diseases. It is further demonstrated by the fact that in blood diseases characterized by extensive red corpuscle destruction high bilirubin content may be demonstrated in the blood stream with no change in the character of the bile excreted by the liver. For example pernicious anemia except in the stage of improvement shows a marked increase in bilirubin serum content of the blood due very probably to the blood destruction associated with this disease while secondary anemia shows no elevation in the bilirubin serum content of the blood.

Jaundice therefore based upon the conception of its origin in the reticulo endothelial system may be of three types (1) The type in which the hemoglobin is converted into bile delivered by the liver cells into the biliary passages and due to obstruction in these passages by stones or malignancy is returned in the vascular circulation to be deposited in the skin as icterus. This is true obstructive jaundice. (2) The type in which due to excessive blood destruction too much bilirubin is formed in the endothelial system to be wholly secreted by the liver cells but a considerable part remains circulating in the blood stream. This is hematogenous jaundice. (3) Finally the type in which bilirubin passes through the Kupfer cells but due to toxic injury to the liver cells it is not secreted by these parenchymal cells. This is toxic jaundice.

This new conception of jaundice based upon the passage or non passage of bilirubin through the Kupfer cells and excretion by the polygonal cells of the liver has been enlarged upon by van den Bergh by means of the diazo reaction now known as the van den Bergh test. Without going into the details of the reaction it appears certain that bilirubin which has passed through the Kupfer cells is so changed that it gives a different

(immediate or direct) reaction from that circulating in the blood (delayed or indirect reaction) without having passed through the reticulo-endothelial cells of the liver venous capillaries. This same direct reaction on the part of bilirubin which has passed through the Kupfer cells is obtained whether the bilirubin tested for be that from the gall-bladder or whether it be bile in the blood-stream secondary to obstruction of the biliary passages.

In the same way, bilirubin which has not passed through the Kupfer cells, but is hematogenous in origin, due, for example, to the excessive destruction of red cells by the spleen, as already cited in pernicious anemia, gives always a delayed or indirect reaction. One must have in mind, of course, that both conditions are not infrequently combined in the toxic and infective type of jaundice so that a so-called biphasic reaction may occur.

Practically, the van den Bergh test is a method by which a quantitative estimation of bilirubin in the blood may be made, whereby the progress of jaundice may be followed and increases or decreases demonstrated. In the same way latent jaundice may be demonstrated. True hematogenous jaundice may be differentiated from obstructive jaundice by the type of reaction, but as an aid in differentiating the various types of jaundice as relates to obstruction of the large or fine bile passages and interference with the liver cells themselves it is of little value.

Painless and progressive jaundice is nearly always caused by the malignant obstruction of the common or hepatic ducts, due to pressure upon these structures from cancer of the head of the pancreas, of the gall-bladder itself, or the occurrence of carcinoma directly within these structures. In connection with these diseases, provided the obstruction has been in any portion of the common duct, that is, below the point where the cystic duct enters the main bile canal, we have rarely seen Courvoisier's law to be at variance with the findings. Courvoisier's law has proved itself, in our experience, to be a valuable law in a large majority of cases. It is, in the presence of jaundice, a dilated gall-bladder (palpable through the abdominal wall), is indicative of biliary obstruction due to malignancy, while a contracted gall-bladder (this may be determined definitely only

at operation) is indicative of obstruction due to stones. Clinically it is at once evident that the positive portion of this law—that is, the portion which deals with dilatation of the gall bladder—is the more valuable and dependable portion since it may be palpated at examination and presents evidence which is of marked weight in arriving at the preoperative diagnosis.

In connection with painless and persistent jaundice we wish particularly to stress the possibility of the existence of a common duct stone without colic. We have had 1 case of painless and persistent jaundice which when explored presented a common duct stone, the removal of which resulted in a complete recovery. This has led us to the conviction that exploration in the case of painless and progressive jaundice with this possibility in mind is justifiable. In this connection care must be exercised lest exploration be done upon cases of infectious jaundice.

It is also our opinion from our experience with cholecystenterostomy that this is distinctly a justifiable operation in the presence of a dilated gall bladder as the union of the gall bladder with the intestinal tract provided the connection between the gall bladder and the hepatic duct is patent results in relief from the almost insufferable jaundice which these patients have endured during the stages of this disease. Even though the mortality particularly in the presence of the so-called white bile indicating at least partial suspension of liver function is high we still feel that an operation which permits them to die in the absence of intolerable jaundice is worth the risk.

Since cholesterol is so constantly present in gall stones since it is so constantly present in bile and since there is an increase in cholesterol in the blood and bile in the later months of pregnancy and since women—and particularly women who have had children—are so prone to have gall stones it is but natural that changes in the cholesterol metabolism should be suspected of being the cause of the frequency of gall stones in women. This is the view advanced and supported by the French school notably Chauffard.

Cholesterol appears normally in the blood in a percentage of 150 to 200 mg per 100 c c. It appears in excess in the bile

after feeding on meat, eggs, and other foods rich in cholesterol. It is increased in pregnancy, diabetes, and in arteriosclerosis.

Chauffard and also Moynihan assert that in most if not all cases of gall-stones the amount of cholesterol in the blood is increased above normal. This is of extreme importance, as if this were true, it would be very valuable in relation to the production of gall-stones, it would be very important as to the avoidance of certain diets rich in cholesterol to prevent the production of gall-stones, and it would be of marked value in the diagnosis of gall-stones.

Unfortunately, conflicting results as to occurrence of cholesterolemia in gall-stones have been obtained by various observers, with the evidence strongly in favor of the finding of normal values of blood cholesterol except in the presence of jaundice, in which case there is an elevation. This fact may possibly, it has been suggested by Campbell, account for the cholesterolemia found in gall-stone cases by Bell in Moynihan's clinic.

But a few cases have been observed in the laboratory at the New England Deaconess Hospital as yet, but in this number no increases have been found.

Chauffard, and Moynihan after him, give all gall-stone patients a diet list in which foods rich in cholesterol are eliminated, such as eggs, stewed and fried foods, sweetbreads, liver, goose, duck, kidney, pork, game, highly spiced food, oily fish, roe, caviar, butter, peas, cabbage, raw vegetables, strong cheeses, and alcoholic beverages.

It is our feeling at the present time, after carefully following the literature on this subject and from the few cases examined in the laboratory of the New England Deaconess Hospital, that the determination of blood cholesterol by a colorimetric method is so often open to variation in results (see reports of Campbell and Hurst) and reports of the findings in blood cholesterol in gall-stones so conflicting, that it is of little or no value as a diagnostic measure in this disease.

The very common association of gall-stones, however, in two of the pathologic states characterized by cholesterolemia, diabetes, and pregnancy, is at least suggestive of a possible relationship.

at operation) is indicative of obstruction due to stones. Clinically it is at once evident that the positive portion of this law that is the portion which deals with dilatation of the gall bladder is the more valuable and dependable portion since it may be palpated at examination and presents evidence which is of marked weight in arriving at the preoperative diagnosis.

In connection with painless and persistent jaundice we wish particularly to stress the possibility of the existence of a common duct stone without colic. We have had 1 case of painless and persistent jaundice which when explored presented a common duct stone the removal of which resulted in a complete recovery. This has led us to the conviction that exploration in the case of painless and progressive jaundice with this possibility in mind is justifiable. In this connection care must be exercised lest exploration be done upon cases of infectious jaundice.

It is also our opinion from our experience with cholecystenterostomy that this is distinctly a justifiable operation in the presence of a dilated gall bladder as the union of the gall bladder with the intestinal tract provided the connection between the gall bladder and the hepatic duct is patent results in relief from the almost insufferable jaundice which these patients have endured during the stages of this disease. Even though the mortality particularly in the presence of the so-called white bile indicating at least partial suspension of liver function is high we still feel that an operation which permits them to die in the absence of intolerable jaundice is worth the risk.

Since cholesterol is so constantly present in gall stones since it is so constantly present in bile and since there is an increase in cholesterol in the blood and bile in the later months of pregnancy and since women—and particularly women who have had children—are so prone to have gall stones it is but natural that changes in the cholesterol metabolism should be suspected of being the cause of the frequency of gall stones in women. This is the view advanced and supported by the French school notably Chauffard.

Cholesterol appears normally in the blood in a percentage of 150 to 200 mg per 100 c c. It appears in excess in the bile

There have been many discussions as to the advantages of cholecystectomy over cholecystoscopy. There are few discussions today as to the reverse condition. If either conception of the origin of gall-stones is true, that they are due either to a concentration of bile in the gall-bladder together with infection, or to the output of cholesterin by the infected walls of the gall-bladder, then nothing short of cholecystectomy insures their possessor against recurrence of his trouble. Cholecystectomy, in our opinion, is the operation to be employed for stones in the gall-bladder and for infection in the gall-bladder except when the conditions in or about the gall-bladder are such that its removal would jeopardize the patient's life, either through the danger of disseminating its infective and virulent contents and producing peritonitis, or when due to obesity or other conditions making the operative risk too great. Under such conditions preliminary drainage with secondary removal is to be employed.

We hesitate even to discuss the question of whether or not drainage should, or should not, be employed following cholecystectomy. It seems to us that the advantages of non-drainage following cholecystectomy are so trivial, compared to the risk attached to this proceeding, that it is not even worth discussing.

Many of the failures in biliary tract surgery are due to persisting common or hepatic duct stones. No operation for gall-stones is complete without wide exposure of the common and hepatic ducts, and incision and exploration of those structures if dilated or presenting any suspicion of harboring stones or infection. Occasionally a dilated common duct will be demonstrated in which no stone will be found, but, on the other hand, rarely will stones exist in the common duct without dilatation of that structure. It should be remembered that often a large part of the common duct is hidden behind the duodenum and that only by mobilization and inward rotation of that structure may the greater portion of the common duct be exposed. On opening the common duct the finding of dark shreds of mucus and débris in the duct is almost certain evidence of the existence of a common duct stone, even though it cannot be palpated. The most common point for stones of this type to

be located is at the ampulla the point where the duct enters the duodenum

When operations must be done upon patients who are jaundiced the liver function test of Rosenthal is of a certain prognostic value in approximating the percentage of liver disability

Cases with diminished liver function and associated jaundice should have careful preparation for operation first by accurate estimations of the bleeding and coagulation time and preparation by calcium feeding until the time has been lowered as much as possible and second by the preoperative administration of carbohydrates to increase the glycogen reserve in the liver since it has been definitely demonstrated that glycogen reserve and lack of it are very intimately associated with liver protection and liver injury

Following operative procedures in patients with biliary tract disease and diminished liver function particularly when this diminished function is due not only to biliary back pressure but also as the consequence of associated infection resulting in a combination of obstructive and infectious jaundice then the continuous employment of intravenous glucose solutions has been of inestimable value in our hands

Much of the mortality following operations upon jaundiced patients has been similar to the early mortality of prostatic surgery It has frequently been due to a prolonged operative procedure under ether anesthesia (a drug badly borne by the crippled liver) upon an individual possessing but little liver function no liver glucose reserve and an associated toxic nephritis as a result of the jaundice

In such bad risk cases the employment of proper preoperative preparation the maintenance of glycogen reserve the use of local anesthesia plus a preliminary drainage operation by means of gall bladder drainage when possible (and it frequently is not) or by a tube in the common or hepatic duct will make possible the rehabilitation of many of these seemingly hopeless cases just as it has in other somewhat similar situations in surgery

CHOLECYSTECTOMY

FRANK H. LAHEY

THE methods of removing gall bladders in various surgeons' hands by the nature of the procedure cannot vary greatly in the main. Gall bladders may be removed from the fundus downward or from the ducts upward. There are however certain procedures in the course of cholecystectomy which in our hands have proved of value in facilitating the removal and added to the security of the procedure.

First as to the selection of cases in which gall bladders should be removed from the fundus downward and those in which cholecystectomy should be performed from the ducts upward. In this clinic it is the rule that in all cases in which adequate and clear exposure of the junction of the cystic and common duct under direct vision cannot be made the gall bladder shall be removed from the fundus downward. In all cases in which a marked induration and thickening exists about the junction of the common and the cystic duct so that clear definition of the cystic artery, cystic duct, common duct and their relationship do not exist the gall bladder shall be removed from the fundus downward. All gall bladders possessing such thick and indurated walls that the traction upon the ampulla or pelvis of the gall bladder necessary to expose the ducts would result in possible rupture of that structure and soiling from septic contents are removed from the fundus downward.

The type of gall bladder disease in which these three conditions arise most commonly is the rigid thick walled gall bladder of subacute cholecystitis often with a stone lodged at or in the cystic duct so that there is enormous distention of the gall bladder the thickening and induration extending downward and involving the cystic, common and hepatic ducts and the

size of the gall-bladder being such that even a glimpse of the ducts and their relationship may not be had.

In such cases it is true that by puncture and evacuation of the gall-bladder it may be possible to so collapse it that exposure of the junction of the common and cystic ducts may be obtained. We prefer, however, to remove the gall-bladder unopened, if possible, which may be done even in those cases in which enor-



Fig 226 —Preparation of peritoneal flaps and removal of gall bladder from the fundus downward

mous dilation has occurred. Fortunately, in the cases of subacute or acute cholecystitis in which this enormous dilation occurs, conditions are most favorable for cholecystectomy from the fundus downward. Many of the small venous channels between the gall-bladder and its bed in the liver have become thrombosed, the wall of the gall-bladder has become so stiff and thickened that peritoneal flaps may easily be made from the walls, and if the fingers be inserted in the proper layer, either at the top or

bottom of the gall-bladder, it readily separates from its bed, leaving behind a pale layer of edematous connective tissue which may later be covered by the peritoneal flaps or packed with a strip of gauze with a piece of rubber-dam laid over it

With the gall-bladder freed from its bed, it now hangs by its cystic duct and cystic artery, which may be exposed by placing



Fig 227 —Introduction of the finger beneath the gall bladder into the line of cleavage separating the fundus of the gall bladder from the liver with acute and subacute cholecystitis in removal of the gall bladder from the fundus downward

a deep retractor over the gall-bladder bed in the liver and retracting it upward. Gentle traction on the gall-bladder now presents the junction of the cystic, common, and hepatic duct seen from behind. By means of a small piece of gauze grasped in the right angle clamps of Lower, and with the aid of a fine and blunt-bladed pair of scissors, the cystic artery may be sepa-

rated from the duct, clamped, and the duct then carefully wiped out until its junction with the common duct is demonstrated, and then cut between clamps and tied.

A disadvantage of the fundus to duct removal of the gall-bladder has been that any bleeding encountered, while separating

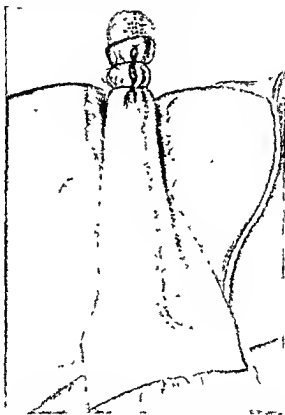


Fig. 228.—Method of packing defect in liver with gauze and covering gauze with an apron of rubber-dam in acute cholecystitis where peritoneal flaps cannot be made.

the fundus from the liver, runs down to later obscure the ducts. A greater amount of drainage is required and there is much more bleeding. The actual removal of the gall bladder, in our hands at least, is accomplished with a greater amount of trauma than is the case with duct to fundus removal. We have there-

fore felt that it should be confined to those stiff-walled gall-bladders not lending themselves well to removal from ducts to fundus

The removal of the gall-bladder from below upward requires, above everything else, an adequate incision. It is essential also that the incision be extended upward as high as possible, since



Fig 229—Semidiagrammatic illustration of the gall bladder entirely separate from its liver attachment. Note Illustration should show cystic artery caught and cut between clamps and ligated first and separately, the gall bladder then being suspended solely by the cystic duct

eversion of the liver edge with its attached gall bladder is often not possible with a low incision.

The next step in the procedure is to grasp the fundus of the gall-bladder with a short right angle clamp and make gentle traction upon it. Another right angle clamp then grasps the dilatation of the gall bladder at its lowest portion, often spoken

of as the pelvis of the gall bladder and a thick warm wet strip is laid longitudinally along the duodenum and a long bladed Deaver retractor placed over the gauze Traction then on the

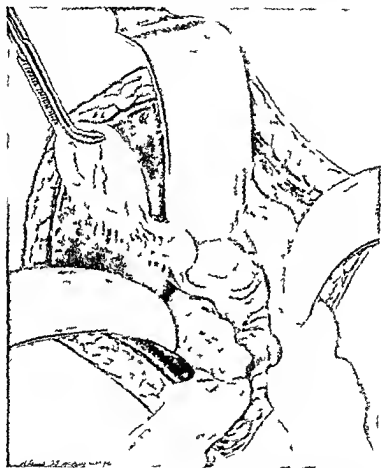


Fig 230—Traction on gall bladder introduction of gauze pads and countertraction on the duodenum Note Gauze pads introduced into the kidney pouch up to the foramen of Winslow (hour glass gall bladder)

pelvis of the gall bladder through the attached cystic duct pulls that structure and the common duct in one direction and dislocation of the duodenum by the gauze pad and Deaver retractor in the opposite direction place the cystic and common ducts so

upon the stretch that they are at once made prominent and much more easily dealt with than when resting lax at the very bottom of a deep hole.

An incision with a sharp knife is then made through the peritoneum over the common duct close to the duodenum and carried up to the point where the common and cystic ducts join. The incision is divided here, one going to the right and one to

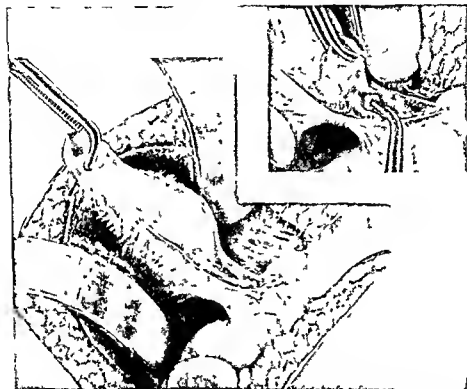


Fig 231 —Showing the peritoneum incised, as described, over the common duct, cystic duct, and gall bladder to make peritoneal flaps. Insert shows pelvis of the gall bladder grasped, lifted, and the cystic duct being wiped out as described.

the left up over the gall-bladder and penetrating only the peritoneum over it. The incisions are carried to the fundus of the gall-bladder and small wads of gauze in the jaws of right-angled clamps wipe back the peritoneal flaps and expose the junction of the cystic and common ducts and the cystic artery. The cystic artery is separated from the duct and the duct and artery clamped and tied separately.

of as the pelvis of the gall bladder and a thick warm wet strip is laid longitudinally along the duodenum and a long bladed Deaver retractor placed over the gauze Traction then on the

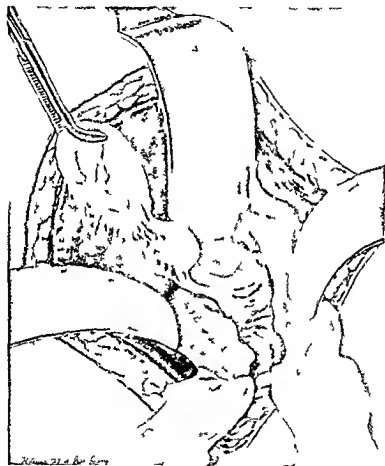


Fig 230 —Traction on gall bladder introduction of gauze pads and countertraction on the duodenum Note Gauze pads introduced into the kidney pouch up to the foramen of Winslow (hour glass gall bladder)

pelvis of the gall bladder through the attached cystic duct pulls that structure and the common duct in one direction and dislocation of the duodenum by the gauze pad and Deaver retractor in the opposite direction place the cystic and common ducts so

cystic duct and artery is done step by step as more and more of the gall-bladder is dissected by blunt scissors from its bed, together with gentle traction on the proximal end of the cystic duct. The peritoneal flaps having been sutured from the duodenum to the upper portion of the defect in the lower made by the removal of the gall-bladder, the operation is completed.



FIG. 233.—Suture of the peritoneal flaps over the common duct, the cystic duct, and the bed of the gall-bladder.

Should it become necessary to explore the common duct, it will not be found difficult with that structure put upon the stretch, as we have described above, to wipe out the duct with the small wad of gauze in the right-angled clamp, as in the case of the cystic duct and artery. The common duct may be recognized by the network of vessels on its wall described by Homans, and not present over the cystic duct. It may be con-

vincingly demonstrated as the common duct by plainly wiping out the point of entrance of the cystic duct into it.

It should be recalled that often more than half of the common duct lies behind the duodenum and is not exposed by the ordinary methods of demonstrating the common duct. For the exposure of that portion the retroduodenal portion of the duct,

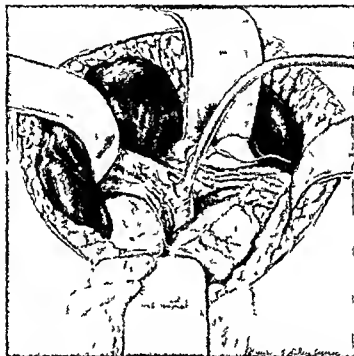


Fig. 234.—Incision of the parietal peritoneum beside the duodenum and mobilization of the duodenum by inward rotation to demonstrate the retroperitoneal portion of the common duct. Introduction of T tube for drainage. No ligation of small vessels running over the duodenum in the parietal peritoneum.

an incision should be made in the parietal peritoneum just external to the duodenum. Numerous small vessels will be found here in the parietal peritoneum to run transversely across and over the duodenum. Bleeding from these small vessels will be found extremely troublesome unless they are ligated and cut between ligatures. With incision of the parietal perit

oneum the duodenum may be wiped gently inward, rotated, and the retroduodenal portion of the duct exposed either down to the part where it enters the posterior wall of the duodenum or, as is often the case, down to the part where it passes through pancreatic tissue.

We believe that this exposure of the retroduodenal portion of the common duct in doubtful cases is of distinct value, as it is in this portion of the duct, close to the ampulla of Vater, that stones are most commonly overlooked.

Incisions made high in the duct close to the cystic duct do not permit of easy investigation of the ampulla region with stone forceps. Where stones exist in the common duct close to the cystic, an incision may be made directly over the stones for easy removal. Where, however, only a dilated duct is encountered and no stone may be felt, as is sometimes the case, with but a single small stone at the ampulla, the rotation of the duodenum with exposure of the retroperitoneal duct with incision in the duct as low as possible often facilitates the discovery and removal of a stone which may be discovered only by the exploring stone forceps within the duct.

Rarely will stones be absent from ducts which are dilated and from which escape strings of mucus or detritus darker than the bile in which they float.

HYPERTHYROIDISM PERSISTING AFTER THYROIDECTOMY. THE NECESSITY FOR POSTOPERATIVE EXAMINATIONS IN TOXIC GOITERS

HOWARD M. CLUTE

It has been the custom in this clinic for many years to examine all patients who have been operated for hyperthyroidism at stated intervals after the thyroidectomy. The routine which we follow, as closely as the circumstances will permit, is to ask the patient to return once every two months for the first six months after operation for metabolic and clinical examination. A final test and examination is made one year after the operation. This system of postoperative care has been of the greatest value to these patients.

Whatever may be the basic cause of primary hyperthyroidism, it is a fact that removal of a large portion of the thyroid gland cures the disease in the vast majority of cases. Just how much thyroid substance must be removed in any individual case to produce a cure can be determined only by long experience. A small amount of very hyperplastic tissue will be sufficient to maintain a normal metabolic rate in one patient. In another case there may be present well-marked involution of the thyroid tissue which will make it necessary to leave a larger section to maintain a normal gland function. The final decision in all patients must rest with the judgment of the individual operator based on his previous experience with similar cases.

These things being true, it is not remarkable that after thyroidectomy in certain cases there will be more thyroid tissue left than is desirable, and that in certain other cases insufficient thyroid tissue will remain. The presence of either of these possibilities can only be known by repeated postoperative examinations of each patient.

The basal metabolic rate follows very closely the clinical improvement after thyroidectomy. It is generally normal within two months if sufficient thyroid tissue has been removed from the neck. Occasionally, however, the rate does not reach normal until four or even six months have passed after the operation, although the clinical improvement in this interval may be relatively great. We have long believed that a persisting high metabolic rate in primary hyperthyroidism after operation indicated that there was insufficient removal of thyroid tissue.

Examination of the neck months after a partial thyroidectomy is often difficult. The anterior face of each thyroid lobe having been removed at operation, the remaining segments will be but little anterior to the level of the cricoid cartilage and trachea. Furthermore the numerous adhesions which are present between the precervical muscles and the thyroid remnants and the scar tissue formation throughout the operative field render accurate palpation of the area impossible without a definite plan of procedure. Such a plan was recently described by Dr. F. H. Lahey.¹ By this method the patient's head is first turned toward the side to be examined and the chin slightly raised from the horizontal. The larynx and cricoid cartilages, together with the thyroid remnants, are now pushed by the non-examining hand toward the side of the neck which is to be palpated. To examine the lobe the thumb is placed over it in front of the sternomastoid muscle and the fingers well behind this muscle. The patient is now requested to swallow, and the thyroid lobe will be felt to move up and down between the physician's thumb and fingers inside the sternomastoid muscle. Many details of the gland can be obtained by this method which would otherwise not be apparent and large remnants of thyroid tissue may often be felt. It is our experience, however, that after thyroidectomy for primary hyperthyroidism good sized pieces of thyroid tissue will be present in the neck in every patient who has an elevated metabolic rate and clinical evidence of thyroid toxicity even though they may not be palpable before operation.

¹ Method of Palpating the Lobes of the Thyroid by Dr. Frank H. Lahey, to be published in Amer. Jour. Med. Assoc.

From a recent study of 48 patients on whom secondary operations for hyperthyroidism had been done in this clinic, we are convinced that the term "recurrent hyperthyroidism," as generally used, implies that the toxic process was completely abated following operation and then after some little interval of health once more returned. To only 5 of the 48 cases in which we have complete records could the term "recurrent hyperthyroidism" be applied. In these 5 patients there existed an interval, averaging two years in which they were clinically cured and showed at some time a normal metabolic rate before there was any return of their symptoms of hyperthyroidism. Such cases in our opinion, can truly be classed as "recurrent." In 19 patients whose records are complete it is evident that at no time were they wholly free from evidence of hyperthyroidism after their first subtotal thyroidectomy. Furthermore, in 24 cases whose records are incomplete we have sufficient evidence in many to warrant the belief that their initial operations never brought any period of complete relief from thyroid toxicity, though some improvement often occurred. For this type of patient we apply the term "persistent hyperthyroidism."

The duration of the thyroidism after the first operation and before the secondary removal of thyroid tissue in these patients varied from three months to fourteen years. In every case at the time of the secondary operation a large sized piece of hyperplastic thyroid tissue was found and removed. In many cases who had been operated upon before the necessity of removing the greater part of each lobe and the isthmus was recognized entire lobes of hyperplastic tissue were present. In 4 cases of the 48 a third subtotal thyroidectomy has been done because of persisting hyperthyroidism. Here as in the other patients, large sized sections of hyperplastic thyroid gland were present.

In this group of 48 patients in whom secondary operations for persistent or recurrent hyperthyroidism have been necessary, 35 are apparently well. They show neither clinical nor metabolic evidence of persisting toxicity to any marked degree. Nine patients are not yet traced and 4 patients are still definitely toxic. There were no deaths, no cases of postoperative tetany, and no postoperative hemorrhages in the group.

In 4 patients there apparently occurred a marked hypertrophy of the small remnants of thyroid tissue left at the first operation so that very large pieces were found at the second operation. One patient in particular has had three subtotal thyroidectomies. At each of these a large piece of thyroid was removed from each side of the neck. This woman is still toxic and a well marked enlargement of the left lobe is again becoming evident. She has taken Lugol's solution regularly for over a year without improvement.

Lugol's solution has been given repeatedly to these patients with recurrent or persistent hyperthyroidism in many cases for periods of a year or more. Usually the metabolic rate has come to normal and the clinical improvement has been marked following its use. In no case that we have followed however has this improvement been permanent unless there was a further removal of thyroid tissue. Lugol's solution has not cured recurrent hyperthyroidism or persistent hyperthyroidism in our experience. Its value in these cases is apparently similar to its value in primary hyperthyroidism where it should be used only as a measure preparatory to thyroidectomy.

It has therefore become apparent in this clinic that all cases of primary hyperthyroidism must be seen repeatedly during the first year after thyroidectomy for the purpose of having both clinical and metabolic examinations. In 95 per cent at least of all these cases both clinical and metabolic evidence of cure will be present in either two or four months after operation and usually much earlier. The presence of clinical evidence of persisting hyperthyroidism and an elevated basal metabolic rate four months after operation however generally means that too large a piece of hyperplastic thyroid tissue is still present in the individual patient under consideration. Lugol's solution may be given but only with the recognition that any improvement in symptoms that may follow is but temporary. In our opinion hyperthyroidism persisting six months after operation is a positive indication for further removal of thyroid tissue.

THE SCHEME OF MANAGEMENT OF GASTRIC AND DUODENAL ULCER IN THIS CLINIC

FRANK H. LAHEY

THE methods of treating gastric and duodenal ulcer have up to the present been quite sharply divided into the medical and surgical with ardent advocates of each frequently denying the need or value of one or the other methods of treatment. Discussions have waxed warm and at times bitter. The advocates of medical treatment have stated that after the surgeons have operated upon the gastric and duodenal ulcer cases they have discharged them without treatment and the patients have come to them for final cure under medical treatment. The surgeons have stated that a great number of the ulcer cases operated upon by them have already had medical cures in varying numbers. A joint meeting of the medical and surgical sections of the American Medical Association on gastric and duodenal ulcers held at St. Louis in 1923, resulted in no approach to any unanimity of opinion, and prompted one of the discussors to remark that the most marked impression he received from the discussion was that it would have furnished excellent material for a Christian Scientist, were there one in the audience.

It is today a demonstrated fact, we believe, that this lack of agreement is largely due to a lack of familiarity of each partisan with the other's methods successes and failures. Those who strongly advocate surgical treatment especially in gastric ulcer, have often felt particularly justified in this course by the incorrectly estimated and assumed danger of high percentages of malignant degeneration in gastric ulcer. On the other hand, surgeons have often, in our opinion been justified in stating that many of the cases upon which they operated had had several medical cures with a return of symptoms due in many instances to attempts on the part of gastroenterologists to

handle such patients medically while up and about, often upon an inadequate plan of medical management and without sufficiently impressing or authoritatively persuading the patient to the necessity of adhering accurately to the scheme of treatment.

A review of the situation a few years ago left us with certain very distinct impressions which will be set down here, one of which was that some headway might be made, at least for this clinic, were it possible to associate a gastro enterologist working directly under a surgeon's vision, demonstrating regularly to us success or failure in the management of gastric and duodenal ulcer of various types in various locations, and with various complications.

We were led to the development of this arrangement following a review of our own surgical results with gastric and duodenal ulcer and following a general review of the medical and surgical situation in this field.

As regards the surgical situation first, there are two types of surgical procedure—conservative and radical. Under conservative come gastro enterostomy, pyloroplasty, and local excision of small ulcers, the representative operation of this group being gastro enterostomy. Under radical surgery come pylorotomy and partial gastrectomy. Of the conservative surgical measures as represented by gastro enterostomy, there must be admitted a mortality varying from 1 to 2 per cent, a failure to cure of approximately 10 per cent in duodenal ulcer and a much higher percentage in gastric ulcer, and an incidence of jejunal or gastrojejunal ulcer very conservatively estimated at 5 per cent. We know of nothing which reflects more justifiable criticism against gastric surgery today in general than the conflicting reports as to the curative value of gastro enterostomy and the incidence of jejunal and gastrojejunal ulcer.

Of the radical procedures, pylorotomy and partial gastrectomy will show a mortality, in most surgeon's hands, ranging from 10 per cent upward. Of the remainder, however, practically all will be cured and will remain so, particularly in partial gastrectomy involving the removal of the acid bearing portion of the stomach.

The medical situation as yet cannot be put down in such certain terms. There can be little question that cure without operation occurs as we surgeons repeatedly see duodenal and, less oft gastric ulcer scars, which show that healing has taken place. As to what the percentage of persisting cures and what the percentage of recurrences are we have no available figures yet.

With the above stated fact in mind, two years ago we established in this clinic (which is primarily surgical) the following plan of procedure, and for the accompanying reasons:

That the diagnosis of gastric or duodenal ulcer should first be definitely based upon adequate data: accurate history, gastric analyses, effect of aspiration, alkalis, and albuminous food upon the typical distress, examinations of stools for occult blood, and fluoroscopic and x ray plate evidence of the ulcer.

That diagnoses of suspected ulcer cases be grouped under the following heads: definite ulcer, doubtful ulcer, and no ulcer.

These two paragraphs are set down because there are two tendencies today which do much to upset the value of results in the non operative treatment of gastric and duodenal ulcer. There is a distinct tendency to assume that every case with a history at all characteristic of ulcer with an associated gastric or duodenal defect by x ray is an ulcer, to treat it as such and to assess the value of the treatment of this group together with the proved group.

Next we have stated that all gastric and duodenal ulcers coming to the clinic, unless possessing definite indications for surgery, and these will be set down later, shall go to bed upon the neutralization regime as devised by Sippy, for three to four weeks and that surgery be or be not undertaken upon these cases based upon their course, progress, and evidence obtained while under this plan of management.

We have employed the Sippy plan of management with its half hour feeding of alternating milk and cream and alkalis for neutralization of hydrochloric acid, and with its careful check by stool examination, biweekly gastric analyses and frequent fluoroscopic examination to determine the healing of the ulcer. Because the method, based upon the assumption that healing

of the ulcer is best permitted in the absence of unneutralized acid seems to us the most logical one and because it permits one to determine from time to time whether or not the basic principle (neutralization) is being attained, and because it has in our hands produced immediate and persisting relief of symptoms in most of the cases with laboratory evidence of healing

Our reasons for employing medical treatment in all cases without surgical indications are primarily because up to the present it has brought about a persisting relief of symptoms with disappearance of blood and disappearance of the x ray picture of the condition in the gastric cases and improvement in the x ray defect in duodenal cases. Furthermore, we believe that it is not justifiable to employ conservative surgery with its 1 to 2 per cent mortality, its incidence of at least 5 per cent gastroyejunal or jejunal ulcer and its failure to cure in 10 per cent of the duodenal and in a greater percentage of gastric cases, or radical surgery, as represented by pylorotomy, or, better, partial gastrectomy with its average 10 per cent mortality, until all the possibilities of the conservative methods of treatment as represented by adequate medical management have been exhausted

We have insisted upon the hospitalization of the cases while under this management not only for the beneficial effects of the rest with partial healing of the ulcer, but because we believe that some of the failures of the medical treatment of ulcer are due to the fact that strict adherence to ulcer management is rarely maintained by the ambulant individual until he has been trained by hospital regimen. This adherence to the plan of treatment is furthered also by a return to the clinic every two months for gastric analysis x ray check up of the gastric or duodenal defect and a critical investigation of the permanency of the relief and adherence to the plan

The cases considered unsuitable for non surgical treatment are those with any question of malignancy those of course, with perforation those in which symptoms cannot be relieved in seven days those in which occult blood cannot be made to disappear from the stools in fourteen days (eliminating blood

from other sources), and pyloric stenoses. In respect to the latter, I must admit that under the medical management of the gastro-enterologist to the clinic, Dr Sara M Jordan, cases of pyloric stenosis have reopened, remained opened, and been relieved of the obstruction and ulcer symptoms. These are cases upon which we would have unhesitatingly and immediately performed a gastro-enterostomy previous to my personal contact and observation of this form of medical management. These cases alone, even without further evidence, would have demonstrated to us the real enlightenment which may be obtained by co operative observation of divergent methods of treatment. Lack of this has retarded and still retards, the clarification of several situations in medicine to the detriment of the patient.

Carcinoma is readily diagnosed, of course, in those typical cases with characteristic findings. It is, however, in the borderline cases—those in which free acid is still present and in which x ray evidence is unconvincing, that helpful information may be obtained from noting the effect of neutralization and management.

In those cases of gastric ulcer in which the character of the x ray defect is not definitely improved following a week or two of treatment under the plan described above, particularly where occult blood persists in the stools, though there be no change in the gastric acidity, carcinoma is to be suspected and radical operation is justifiable.

Without this evidence exploratory operation is of little value, since most of those cases with typical gastric carcinoma show quite convincing evidence by x ray, stool, and gastric analyses previous to the operation, and are, therefore, not submitted to preoperative management. In these borderline cases however little in the way of convincing preoperative evidence such as characteristic x ray, absence of hydrochloric acid, etc., is consistently present. In such cases and we wish particularly to emphasize this point, exploratory operation often reveals a small deep ulcer which, however possesses no features distinguishing it as certainly carcinomatous or non carcinomatous.

The surgeon therefore is placed in a situation which is most unsatisfactory and perplexing if he subscribes to the views laid down in this discussion first that the percentage of malignant degeneration in gastric ulcers is not sufficiently high to justify resection of all such lesions for this reason alone and second that under proper medical management and co-operation of the patient such ulcers may be healed

If of course one feels that the danger of malignancy is great and the likelihood of cure by non surgical measures slight then he may readily justify the risk of subtotal gastrectomy even when exposure of the ulcer reveals no frank evidence of the presence of carcinoma

But he who believes less in the inevitable malignant degeneration of gastric ulcers and more in the possibilities of medical cures finds himself confronted by a lesion which is either ulcer or malignancy. He must either close and watch the progress of the lesion with the possibility of leaving behind a carcinoma or submit the patient to the mortality risk of partial gastrectomy in spite of his conviction that should the lesion prove an ulcer it possessed definite possibilities of medical cure without the attendant risk attached to the surgical method. In such cases then as we have emphasized above in cases of gastric ulcer with suspicious but not characteristic evidence of malignancy information of real value in determining the need and justification of partial gastrectomy may be obtained during the progress of medical treatment and this within a period of two weeks a time not too long when one considers the value of the information which may be obtained

This information consists in demonstrating the effects of medical treatment. If ulcer relief of symptoms disappearance of blood and improvement in the x ray picture. If the condition be malignant no change either in symptoms or x ray picture will occur

When medical management has failed and surgery in duodenal pyloric or prepyloric ulcer must then be accepted we admit to a state of mind at present that is far from one of firm conviction. Reports as to the incidence of gastrojejunal ulcer

being so connecting together with the fact that more careful following up of our operated cases has shown an increasing number of gastrojejunal ulcer, does not permit us to accept the more conservative procedure of gastro-enterostomy so complacently as the procedure of choice in the lesion as we have in the past. Nor do we any more complacently view the procedure of partial gastrectomy with its 10 per cent. post-operative mortality for duodenal or pyloric ulcer as advocated by the opponents of gastro-enterostomy.

Partial gastrectomy must of course be undertaken regardless of the risk is reasonable, in the frank cases of gastric carcinoma and the case be operable. The decision to perform this operation for a benign lesion however such as ulcer should be reached only after a careful contemplation of the entire situation, the readiness of approach and ease of mobilization of the pylorus and portion of the stomach to be removed with due consideration of the fact that the removal is often the easiest part and the subsequent anastomosis between the bowel and stomach most difficult, the length of time probably necessary to do the operation with allowance for the fact that it is frequently longer than anticipated, the possible effect of the anesthetic shock and finally the facility and experience of the individual undertaking the procedure. With such facts in mind we urge that where any marked degree of doubt exists as relative to any of these factors a conservative gastro-enterostomy, even with considerable risk of gastrojejunal ulcer be done which always permits of later removal under more favorable conditions upon a better risk patient and with a considerable part of the operation already done.

ETHYLENE USES AND PRECAUTIONS

LINCOLN F SISE

ETHYLENE has been used by us since December 1924, and at the present time considerably over half our cases are being done either in whole or in part under this anesthetic. Nitrous oxid has been almost discontinued. We are now using ethylene.

1 Where deep relaxation is not necessary and where the fields of the anesthetist and the surgeon are not too close together. This means that it is used in practically all operations except those on the abdomen or the head. The largest and most important single group of operations consists of those upon the thyroid gland. In these operations it has become the routine anesthetic.

2 In many abdominal operations where ether is contra indicated. Ethylene does not appear to be the anesthetic of choice for abdominal operations. Under full ether anesthesia relaxation is very much better and the operation can be done more quickly and surely and practically without limitation on account of the anesthetic. While ethylene is not, therefore the anesthetic of choice, nevertheless, where there are lung or kidney complications, severe diabetes, or weakness from old age or disease, ethylene is the safer and better of the two anesthetics even for an abdominal operation.

3 In the course of abdominal operations under ether, where the patient begins to show signs of approaching shock. This may or may not have been anticipated as a possibility before the operation. In either event the change to ethylene is usually followed by a distinct improvement and the patient's condition is maintained better than under full ether anesthesia. Ethylene is continued during that part of the operation where deep re

laxation is not necessary. For closure, ethylene may be continued, ether may be added to it, or a shift may be made back again to full ether anesthesia depending on the condition of the patient.

We have taken up the use of ethylene in preference to nitrous oxid for the following reasons:

1. It is possible to use more oxygen with ethylene than it is with nitrous oxid. This is the chief and outstanding advantage of ethylene. Under it usually from 10 to 20 per cent of oxygen may be used, where under nitrous oxid we can seldom use more than 10 per cent. Thus under ethylene there is a wider margin of anesthesia before asphyxia is reached. Under nitrous oxid this margin of anesthesia is sometimes very narrow and occasionally so narrow as to reach almost to the vanishing point. Thus we may say that *under ethylene the margin of safety is wider*. It is safer especially for the weak, those in poor general condition, for cardiac cases, and for those who are especially resistant to gas anesthetics. There is less anoxemia with ethylene. Under nitrous oxid there is always with every anesthesia at least a certain amount of anoxemia. While there is usually probably some under ethylene, it is certainly less than with nitrous oxid, and may even sometimes be absent entirely.

2. Respiration is notably quieter under ethylene. It is less rapid and less deep. It is possible that this phenomenon is a corollary of the increased amount of oxygen possible. Whatever its cause, this quiet respiration is of advantage with patients having lung involvement, and probably also with those having thyroid toxicity.

3. There is more relaxation than is obtained with nitrous oxid, though of course the relaxation is not to be compared with that obtained with ether. Nevertheless ethylene is much to be preferred to nitrous oxid in abdominal operations where ether cannot be used. It is also possible under ethylene to operate on the patient in stirrups, while this is quite difficult to accomplish under nitrous oxid. Ethylene is quite valuable for bimanual examination of the pelvic contents. Hemorrhoids should not be done under it if the operation is with a cautery.

4. Analgesia is apparently greater under ethylene than under nitrous oxid. Patients may be run in a slightly lighter plane of anesthesia, and their reflex to operation is less.

Quietness of respiration was mentioned above as an advantage. This quietness is but a form of depression of respiration, and this depression is more marked with ethylene than it is with nitrous oxid. With ethylene it may become very pronounced, especially where much preliminary drugging has been employed. With thyroid patients we usually give a comparatively large amount of preliminary drugging in order to lessen preoperative apprehension. With such patients there is frequently a marked depression of respiration, especially during induction. At this time the depression may be so great as to render it difficult or impossible to secure in a reasonable length of time sufficient depth of anesthesia to start the operation. We therefore use as a routine during induction in all cases where much preliminary drugging has been employed, except severe cases of hyperthyroidism, carbon dioxid to stimulate respiration. Induction is thus quickened decidedly, and the period of depression is entirely eliminated. When induction has been completed the flow of gases may be cut down and respiration stimulated by rebreathing. Carbon dioxid may be of value at any time during an inhalation anesthesia. It will stimulate respiration if this becomes depressed. If the patient becomes too light it will force him to breathe in the anesthetic, so that he can be put under more quickly; and if he becomes too deep, it will help him to exhale the anesthetic, so that he can be brought out from depth more quickly. With ethylene (and to some extent with nitrous oxid) its use sometimes enables us to obtain greater depth with equal safety, for the stimulation of depressed respiration enables us to use a stronger mixture and still keep the patient sufficiently oxygenated.

Carbon dioxid has a stimulating effect on both respiration and circulation. This is undesirable in cases of hyperthyroidism, as these cases are already overstimulated by their disease. In cases of hyperthyroidism, therefore, we avoid carbon dioxid. To do this we use a large flow of gas and a minimum of re-

breathing. In most cases we use a small amount of carbon dioxide for a short time during induction only and in the more severe cases we avoid it entirely unless there is considerable depression of respiration during induction. But for the rest of the anesthesia we use a rather large flow of gas without any carbon dioxide. This procedure gives an extremely quiet respiration and stimulates the patient as little as possible.

Freezing of the valves during the administration of ethylene may be quite troublesome. It is almost certain to take place unless some provision is made against it. It is due to the rapid expansion of the gas at the control or reducing valve from the high pressure within the tank to that of the atmosphere or near it.

The tendency is lessened if the flow of gas is small. The safest heating device to use on the machine is a hot water bag. We have here worked out a scheme by means of which the tanks of ethylene are used in such a way that no heating device whatever is necessary. This scheme depends on the fact that ethylene within the tanks at ordinary room temperature is in the form of a compressed gas and not in the form of a liquid as is nitrous oxide. Thus the pressure within the tank goes down exactly in proportion to the amount of gas which is used from it. With nitrous oxide there is practically no lowering of pressure until the liquid has all been used and there is only the gas left within the tank. When the ethylene tank has been about half emptied the pressure within it has been so lowered that freezing will no longer take place at the control valve. We therefore use ethylene from two tanks at the same time, one of which is at least half empty. If for instance we start with tank 'A' half full and tank 'B' entirely full we use from tank 'B' as much as possible up to about half the total amount. The balance is used from tank 'A' and all the adjustments are made from this tank. If at any time we need a large flow of gas we can get it from tank 'A', though it would not be possible to get it from tank 'B', but by the time that tank 'A' is empty tank 'B' is approximately half empty, and is shifted to the position of the original 'A' tank, while a new tank is put in in place of tank 'B'. Thus, by distributing the production of cold

between the two tanks and by having one tank always at least half empty, we can always get the desired flow of ethylene without danger of the gas shutting off through freezing at the valve.

In working with ethylene its inflammability must always be borne in mind. This feature of ethylene is the outstanding objection to its use. A knowledge of the precautions necessary in order to avoid trouble from this feature is so important that it will be discussed even at the risk of repeating much that has already been said.

Ethylene "is inflammable, and when mixed with certain amounts of oxygen or air is highly explosive. Mixtures with oxygen must have a maximum of about 60 per cent. ethylene to be explosive, and the greatest violence of explosion comes with about 25 per cent. ethylene. With air 5 to 10 per cent. ethylene is explosive. Richer mixtures than these can be ignited, but do not explode. Leaner mixtures cannot be ignited, nor do they explode. A mixture of ethylene and oxygen, if subjected to high pressure such as occurs within the tanks, may explode spontaneously."¹

The mixtures most commonly used during anesthesia run from about 75 to about 90 per cent. ethylene. They are, therefore, too rich to explode. Occasionally, however, for short periods and in a very few instances, perhaps continuously, a mixture may be used which is weak enough to fall within the limits of explosibility. The mixtures commonly used, while too rich to explode, are still inflammable and may catch fire just as ether may. It seems probable, however, that they may "catch fire more easily than ether because they remain inflammable at a greater distance from the mask. The ether mixture is near the lower limit of explosibility. Consequently it takes very little dilution with air to weaken it beyond the point at which it will ignite. Moreover, ether vapor is about two and one-half times heavier than air and tends to drop to the floor out of the way. The ethylene mixture is too rich to explode. Therefore, as it drifts away from the mask and is diluted with air, it becomes explosive

¹ Sise, Boston Med. and Surg. Jour., 192, 7, p. 287, February 12, 1925.

at a distance where ether would perhaps have become too weak to ignite, and then this explosive mixture has to be diluted still further before it will be too weak to ignite. Consequently it seems probable that it will catch fire at a greater distance from the mask than will ether. Moreover, it is of almost the same weight as air and so may drift in any direction.

"There seems no danger that a room could get so full of ethylene that its contents would form an explosive mixture and the whole room be exploded *en masse*.

' All possible sources of ignition should be kept out of the operating room. There is a wide variety of such sources, chiefly the cautery and sparking electrical apparatus such as fulguration apparatus, x ray, or ventilating fans. Electric currents, particularly of high amperage such as those used with heaters, should not be switched off. If they *must* be switched off, care should be taken to see that any possible drift of ethylene toward them is broken by making a current of air across the drift.

' The most elusive form of ignition is the static spark. That the danger from this source is by no means imaginary is shown by several recorded instances. Ethylene gas flowing over insulating material such as rubber so commonly used in the leads from gas machines, may form a static charge. One may be formed by the motions of a breathing bag and especially by the motion of the bag against an enclosing fabric netting.

"To guard against these various sources insulating material should be avoided, and machine, table, patient and anesthetist should be connected together by an electric conductor. The rubber leads from the machine should be replaced by metal, or at least a wire preferably spiral should be run down the inside of the rubber tube. For the small tubes the flexible metal tubes used for gas appliances are excellent. The machine, table, and patient may be connected together by copper wire" and all may be grounded by running a metallic connection to some suitable ground. "The anesthetist should then take hold of some part of this group before turning on the ethylene and so ground himself to the same potential. Metal masks should be used instead of celluloid, as, in the event of the ethylene catching

fire, it seems probable that the patient may receive a worse burn from the explosion of the celluloid than from the ethylene."¹

The breathing bag sometimes offers a problem. Where the bag is close to the patient, the inside is probably sufficiently moistened by the patient's breath to cause any static charges to leak off. If the bag is at a distance from the patient, a fine chain should be run through it and soldered to the nearest metal parts. Where it separates two metal parts, these should be connected together carefully by wire or small metal chain. Fabric netting around the bag should be replaced by electrically conductive netting carefully connected to neighboring metal parts.

The greatest danger from static electricity comes in the dry winter months, while in the summer time there is comparatively little danger. In the winter time the danger may be lessened somewhat by moistening the air of the operating room. The steam from the sterilizer may sometimes be utilized for this purpose.

"Ethylene tanks should never be attached to any apparatus which has been used with oxygen nor should oxygen tanks be attached to any apparatus which has been used with ethylene, as explosion may occur when the high tank pressure is turned on. In fact, reducing valves for ethylene are made with a left-hand thread, which fits the left hand thread on the large ethylene tanks and makes it impossible to attach these valves either to oxygen or nitrous oxid cylinders.

"Explosion of ethylene within the tank itself seems altogether unlikely as these tanks are shipped freely by the manufacturers, and in the recorded instances where the gas has been ignited during administration no trouble has been experienced with the tanks. The storage of extra tanks should receive attention. A leaky tank in a small, ill ventilated room might form an explosive mixture. A safety valve might conceivably blow, with the sudden release of a large quantity of ethylene. The extra supply should therefore, be stored in a room shut off from the rest of the hospital but freely ventilated to the outside."²

¹See Boston Med and Surg Jour, 1927, p 287 February 12, 1925

²Ibid

A large proportion of the recorded explosions have taken place before anesthesia was begun and as the mask was about to be placed on the patient's face or after the anesthesia was finished and as the mask was placed back on the machine. In each case the ethylene flowing from the mask was undoubtedly ignited by a static spark. We have made a practice of beginning and ending our ethylene anesthesia with nitrous oxid thus eliminating the danger at these two particularly dangerous points. We begin with nitrous oxid and shift to ethylene in one half to one minute and shift back again to nitrous oxid about five minutes before the end of the anesthesia. Besides eliminating the danger of explosion at these two points the procedure has two other advantages. The induction is pleasanter to sensitive patients because the smell of nitrous oxid is less objectionable than is that of ethylene. There is slightly less tendency to nausea immediately after the operation because nitrous oxid seems to be less nauseating than ethylene.

SOME PHYSIOLOGIC ASPECTS OF POSTOPERATIVE TREATMENT

ROBERT L. MASON

THE application of knowledge gained by research in normal and pathologic physiology during the past few years has been of inestimable value to all forms of surgery. With a better understanding of the mechanisms underlying normal physiologic processes has come the appreciation of the effect of disease on these mechanisms. Attention has been diverted from therapeutics based on anatomic pathology to measures which tend to restore physiologic harmony. Improvements in biochemic methods have made possible qualitative and quantitative tests, which, together with an understanding of the disturbed physiology, furnish criteria which render diagnosis more exact, treatment more rational, and prognosis more certain.

A marked reduction of surgical mortality has been effected by preoperative preparation based upon data showing the functional condition of those organs which regulate the chemical physiology of the body. Equally important is the postoperative treatment based upon data of similar nature.

In our observation those cases which most need, postoperatively, the type of treatment based on underlying disturbed physiology fall into three groups:

1. Cases in which the operation removes the cause of the disturbed physiology, but leaves a residuum of the results of the previous disordered function to be reckoned with postoperatively. This group includes cases following operations for hyperthyroidism, high intestinal obstruction, biliary tract disease, and prostatic obstruction.

2. Cases in which the postoperative reaction brings about a train of symptoms which are a manifestation of disordered

chemical physiology. Examples are the development of post operative acidosis or alkalosis.

3 A group of cases which, although presenting no definite symptoms, withstand operations poorly and do not react well during the postoperative period. Patients advanced in years or with vitality at a low ebb fall into this group.

Since these groups include so large a portion of cases presenting themselves for major surgery, a complete discussion of their postoperative treatment would take more space than is here permitted. Accordingly, but a few fundamental facts of each will be indicated.

HYPERTHYROIDISM

Hyperthyroidism furnishes a classical example of the first group. Most of the symptoms of thyrotoxicosis are incident to the high rate of energy exchange that occurs as a result of the elevated metabolic rate. Treatment of the disease consists in measures designed to combat these effects and in ultimate excision of a portion of the gland in order that the cause of the elevated metabolism may be removed. During the preoperative period all possible means are taken to combat the effects of the high metabolism. When the patient's condition is improved to the highest extent possible with these measures operation is undertaken. In the immediate postoperative period the metabolism is considerably accelerated beyond the preoperative level. While it is important to attempt to lower the metabolism by Lugol's solution and to quiet the patient by large doses of morphin, the urgent indication is to meet the demands of the highly elevated metabolism. Chief among these is the need for fuel to supply the increased energy requirement. The food intake on the day of operation is apt to be greatly reduced. Following the operation vomiting prevents adequate intake. The food reserves of the body are, of necessity, called upon to furnish the required calories.

Excessive oxidation of sugar takes place in hyperthyroidism and especially during this period. From data derived from a consideration of the total respiratory quotient in hyperthy

roidism,¹ 36 per cent. of a dose of 100 grams of glucose has been shown to be oxidized in two and a half hours; the normal figure is 18 per cent. Animal experiments by several investigators have shown a depletion of the glycogen in the liver in cases of induced hyperthyroidism. Postoperatively, with a sudden activation of metabolism and a diminution in the amount of food supplied, the available supply of carbohydrate is quickly reduced. With the glycogen stores depleted the proteins of the body tissues (of which 58 per cent. can be converted into carbohydrate) are broken down to meet the demand for a readily oxidizable food substance. Rapid weight loss occurs. The waste products of protein catabolism, urea, and ammonia, require elimination and throw an increased burden upon the kidneys. Fat, also called upon to furnish an increased amount of heat energy, is imperfectly oxidized in the presence of an insufficient supply of carbohydrate, and acidosis is prone to develop. The administration of glucose in a form readily utilizable is therefore indicated.

Ordinarily the carbohydrate may be furnished in drinks containing a considerable amount of carbohydrate, such as orange juice, ginger ale, etc., and by rectal glucose. In reactions of any severity, however, and especially when a thyroid "storm" seems imminent, the intravenous administration of glucose is indicated and, as a rule, is followed by a striking improvement in symptoms. Five hundred c.c. of a 10 per cent. solution should be given and repeated, if necessary, two or three times during the twenty-four-hour period.

Water is another fundamental requirement in the postoperative treatment of hyperthyroidism. The heat generated by the increased metabolism must be removed by evaporation, and for this purpose an increased supply of water is essential if dehydration is to be prevented. The intravenous administration of glucose in a 10 per cent. solution serves a double purpose, in that, besides glucose, a generous amount of water is supplied. To further supply the increased demand for water fluid should be given by rectum and the patient urged to drink large quantities of water in spite of emesis.

¹ Sanger and Hun, *Arch. Int. Med.*, 1922, 30, 397.

INTESTINAL OBSTRUCTION

In high acute intestinal obstruction the associated toxemia remains to be treated following the operative removal of the obstruction. A similar toxemia accompanies the high intestinal stasis which occasionally follows operations on the stomach or duodenum. This toxemia has been shown by numerous investigators to be accompanied by definite chemical changes in the blood. These are manifested by

- 1 Reduction in plasma chlorids
- 2 Alkalosis as shown by a rise in the carbon dioxide combining power of the plasma
- 3 A rise in the non protein nitrogen

The cause of the development of the hypochloremia and the attendant alkalosis is not clear. Prolonged vomiting has been ascribed and probably does play some part although Haden and Orr have observed similar conditions following experimental obstruction in rabbits—animals who cannot vomit. It has also been observed in pyloric obstruction accompanying gastric carcinoma in which no chlorids are lost in the vomitus by virtue of the achlorhydria present in this condition. Starvation may be a factor. The experimental work of Haden and Orr would indicate that the chlorids are utilized by the body as a protection against the toxic agent generated by the obstruction. This toxic agent they believe has a marked destructive action on protein and to the resultant split products are due the symptoms associated with toxemia. A sufficient concentration of chlorids prevents this tissue breakdown by effecting a combination of the chlorids with the toxic body which renders it innocuous. Haden and Orr suggest the following equation as one conception of this protective mechanism



The same observers have also shown that the rise in non protein nitrogen occurring in these cases does not occur until there is a considerable depletion of the chlorids. (In one series the NPN did not rise until 25 per cent of the chlorids had been depleted.) They have shown that if the chlorids are kept at a normal level

the non protein nitrogen does not rise, the CO_2 combining power of the plasma is not elevated and no symptoms of toxemia develop

This conception at least, furnishes a working basis for treatment in these cases and an explanation of the marked improvement which follows the administration of sodium chlorid and other measures to restore the blood chlorids to a normal level. We have had excellent results in the treatment of these cases by the intravenous administration of large quantities (1000-1200 c c) of normal physiologic saline solution with the addition of 50 to 100 grams of glucose as advocated by McVicar. In obstinate cases we have accelerated the return of chlorids to normal values and lowered the CO_2 combining power to a normal level by the rectal administration of 300 c c of a 2 per cent solution of ammonium chlorid at four hour intervals. The efficacy of ammonium chlorid in combating alkalosis and raising the blood chlorids has been well shown by the work of Haldane, Ellis and others.

A generous supply of water furnished by the massive intravenous infusion aids in eliminating the excess nitrogenous waste products and combats the anhydremia incident to the toxemia. The glucose added to the intravenous saline furnished a readily oxidizable food substance and spares the breakdown of tissue proteins.

The blood chlorids and CO_2 combining power of the blood should be carefully followed in order that the subsequent treatment may be decided upon. The administration of ammonium chlorid should be stopped upon the return of the CO_2 combining power to normal values (50-70) since further administration may lead to acidosis.

BILIARY OBSTRUCTION

In the routine case of gall bladder disease without jaundice or fulminating acute infection one does not often meet with serious postoperative sequelæ.

When jaundice is present however the postoperative course is beset with three possible dangers

- 1 Hemorrhage
- 2 Failure of liver function
- 3 Kidney failure

These have been emphasized by Walters and his co workers at the Mayo Clinic

In patients who have had a careful study of their bleeding and coagulation time previous to operation and who have had these reduced to normal levels by a course of oral and intravenous calcium the danger from hemorrhage is not great. If considerable blood is lost at the operation transfusion immediately afterward should be done as a precautionary measure. Since the improvement in the coagulation time is not always sustained calcium lactate should be given by mouth 100 grams daily for at least five days following the operation. If not tolerated by mouth it should be given by rectum. Besides accelerating the coagulation time the calcium may have some detoxifying effect upon the excess bile pigment in the blood as suggested by King and Stewart. If hemorrhage occurs in spite of these measures transfusion must be done without delay.

The other two possible complications are often confused. Liver failure is apt to occur several days after operation during which time the patient has appeared to be making a satisfactory convalescence. Its onset is accompanied by a thinning in color and increase in amount of the bile drainage. The patient becomes apathetic listless and marked emaciation occurs in a surprisingly short time. The jaundice does not appreciably deepen. The phenoltetrachlorophthalein test of Rosenthal shows an increasing degree of dye retention. Urinary output is commensurate with intake. Since the manufacture of urea is a function of the liver the blood urea remains at a low level although the total non protein nitrogen may show a rise due to the increased endogenous protein metabolism. Acidosis is prone to occur due to the imperfect oxidation of fat in the presence of insufficient carbohydrate. The patient fails rapidly and goes into a state of collapse.

In kidney failure however the patient is apt to have a prolonged initial operative recovery with vomiting nausea,

and distention The bile drainage is of normal color, but of small quantity The urinary output is decreased The serum bilirubin increases and the jaundice deepens The blood urea, the non protein nitrogen and the blood creatinin show marked elevation and the excretion by the kidney of phenolsulphthalein is at a low level The urine shows marked albuminuria and the sediment shows casts Uremia rapidly develops

While these two serious complications with their typical manifestations are fortunately, not common, milder degrees of each or their combination are frequently encountered following operations for biliary obstruction in which jaundice has been severe Some degree of liver impairment as shown by the phenol tetrachlorophthalein and levulose tolerance test, almost always exists if the jaundice has been of more than temporary duration The toxic action of the bile salts and bile pigments upon the kidney is well known Haessler¹ and his associates have found extensive degenerative changes in the tubular epithelium of the kidneys of dogs jaundiced for a considerable period The glomeruli were practically unaffected One would infer from these and other reports of the toxic effect of bile upon the kidneys that the margin of safety as regards the renal mechanism is distinctly lessened in obstructive jaundice If the patient already has renal damage the added increment of pathologic changes incident to jaundice may be sufficient to bring about renal failure especially after operation when the effect of anesthesia has added to the kidney burden

The specific action of glucose in liver impairment has been well demonstrated by the work of Mann After extirpating the livers of dogs he has been able to keep them alive and active for thirty six hours with intravenous glucose Dogs which did not receive glucose developed a progressive hypoglycemia and died in six hours Clinically, in failure of liver function the use of glucose is attended with very satisfactory results and in cases of liver failure after operation as noted above is urgently indicated In these cases it is best given as a 10 per cent solution in

¹Haessler H Rous P and Brown G C Jour Exper Med 35 533 1922

normal saline. Fifty grams of glucose may be given in this way and repeated two or three times during the twenty-four hour period. Care must be taken that this solution is given slowly or a considerable portion will be lost in the urine. At least one hour should be taken in the administration of 50 grams of glucose. In addition to the carbohydrates furnished intravenously the patient should receive a copious supply of carbohydrate in drinks and in his diet. Fluids should, of course, be forced. Ox bile by mouth may be of value by virtue of the cholagogue action of its bile salts.

In kidney failure intravenous glucose is of equal value, but should be given in a 10 per cent solution with distilled water rather than saline solution. The glucose acts both as a readily oxidizable food substance and as a diuretic. The large amount of fluid combats the dehydration and facilitates elimination. The other usual measures for restoration of kidney function are, of course, indicated. Drains should be carefully inspected to make sure that they are not obstructing the outlet of bile.

ACIDOSIS AND ALKALOSIS

The prolongation of the initial operative recovery after any major surgical operation, with persistent vomiting, restlessness alternating with periods of languor together with slight elevation of temperature and flushed skin, lead one to suspect acidosis. The circumstances incident to the operation are propitious for its occurrence.

Previous to operation the food intake has been limited, especially in acute cases or where there has been considerable vomiting. Fluids and food are apt to be reduced in anticipation of the anesthetic. Following the operation food intake is necessarily at a minimum and much fluid is lost through vomiting and profuse perspiration. The glycogen reserve of the liver is rapidly depleted. The body must now derive its heat energy from the fat and protein of its own tissues. In the presence of insufficient carbohydrate combustion of fat is incomplete and the intermediate products of fat metabolism, acetone, diacetic acid, and beta-oxbutyric acid accumulate in the blood stream.

There results a diminution of the alkali reserve from the combination of these acids with the circulating bases. The carbon dioxide combining power is reduced. Acetone bodies appear in the urine. The anhydremia present acts in conjunction with the acetone bodies and diminished base to produce the clinical symptoms of acidosis. Talbot Shaw and Moriarty,¹ in a study of fasting children with acidosis have shown that there were few subjective symptoms as long as large amounts of water were ingested and excreted. When the fluid intake was materially diminished their patients became flushed, anxious, languid, and complained of abdominal pain.

Since the condition is due to an insufficient supply of carbohydrate, the administration of this substance results in prompt disappearance of the ketosis and a return of the carbon dioxide combining power to normal values. Sufficient carbohydrate may be given by mouth if the patient is able to retain it, most of them cannot. By rectum glucose is apt to be irritating and even with considerable dilution is not well tolerated. We have had very satisfactory results as in other instances, where carbohydrate is urgently indicated by the intravenous injection of a 10 per cent solution of chemically pure glucose in normal saline solution. Fifty to 75 grams may be given in this way at one administration and in addition a generous amount of fluid supplied. The results are striking and usually follow one intravenous injection. Vomiting stops, restlessness is allayed, and the patient experiences a considerable measure of subjective relief. Insulin has been advocated as an adjunct to the glucose in hastening its oxidation. We have used this procedure in a few cases but can see no advantage over the administration of glucose alone. In postoperative acidosis there is no inability to utilize carbohydrate, the difficulty lies in an inadequate supply. If introduced slowly, the glucose by vein is efficiently utilized and the acidosis relieved. Insulin in the non diabetic has been shown to reduce the glycogen content of the liver, and in these cases with the carbohydrate reserve at a low level further depletion would be unwise.

¹ Talbot Shaw and Moriarty, *Jour Amer Med Assoc* 83:93, 1924.

The use of alkalis commonly sodium bicarbonate, in the treatment of surgical acidosis is unnecessary and may often be harmful. Aside from the danger of tetany from overdosage of alkali the amount of base required to neutralize the ketone bodies would produce an absolute excess of base in the blood and in this way disturb the normal equilibrium of the body fluids. Sodium bicarbonate is excreted with difficulty if any renal impairment exists and its retention leads to edema.

In many cases suspected of acidosis because of prolonged vomiting restlessness and headache the CO_2 combining power will be found to show a condition of alkalosis rather than acidosis. This may even occur in cases showing acetone bodies in the urine and illustrates the value of determining the CO_2 combining power of the plasma in suspected cases of acidosis. Tetany occurs in severe cases with a CO_2 combining power over 90 volumes percentage.

As in the alkalosis accompanying intestinal obstruction, there is apt to be a reduction in the plasma chlorids. The NPH however is usually not elevated. In these cases vomiting has been prolonged and the condition is undoubtedly due to loss of hydrochloric acid in the vomitus. Similar blood chemical changes however may occur with slow dilatation of the stomach with accumulation of gastric secretion.

The treatment of this variety of alkalosis is the same as that described for the alkalosis associated with the toxemia of intestinal obstruction. Intravenous glucose in normal saline solution as described is of great value. In addition in severe cases or if the CO_2 combining power remains persistently high, ammonium chlorid may be given by rectum in a 2 per cent solution 10 ounces at one administration.

PROSTATIC OBSTRUCTION

In prostatic obstruction operation is only undertaken after a preoperative period during which intravesical tension and congestion have been relieved by suprapubic or urethral drainage. The patient during this time has been able to establish a certain amount of immunity to infection from the bladder, and the

retention of nitrogenous waste products has been brought down to a normal level by copious fluid intake. After removal of the prostate there is a tendency toward return of the pathologic conditions relieved by the above measures. The congestion and edema of the bladder incident to the prostatectomy act reflexly on the renal blood pressure and the rate of urine flow is decreased. There may be an exacerbation of bladder and ureteral infection if this has been a prominent factor before operation. These interfere with efficient kidney function. If, however, the accumulation of nitrogenous waste products can be kept at a minimum for a few days following the operation the congestion and infection tend to subside. The inefficient kidney in the face of its added burden is able to do this only by copious excretion of a poorly concentrated urine. For this purpose fluids must be forced to at least 3000 c.c. daily. Most cases are unable to maintain this high level by mouth, and the fluid must be given by hypodermoclysis or by vein. We have found the intravenous route to be the most satisfactory. It is far less painful to the patient and has the advantage of being taken into the circulation at once. Fluid is often inefficiently absorbed from the subcutaneous tissues. One thousand c.c. of normal saline may be given at one intravenous administration.

The diet should be one which leaves but small residue of its end products for excretion by the kidneys. Carbohydrates furnish heat energy efficiently and place no burden upon the kidneys. They should comprise a large portion of the diet.

If food is not taken adequately by mouth, glucose may be added to the intravenous saline solution.

DEBILITATED PATIENTS

In the third group of patients are those who though presenting no definite syndrome, react poorly to the operative procedure and in spite of the usual restorative measures, go steadily down hill. They are not in shock, nor have they lost much blood. They are usually advanced in years or by reason of their illness or otherwise have been invalids over a long period of time. On investigation dehydration is a prominent factor in

their condition and has usually been of long standing. Blood volume is diminished and viscosity of the blood increased in the resultant desiccation. Tissue oxidation is inefficient due to the increased viscosity. Kidney function is inefficient because of the high concentration of the waste products brought to it for excretion.

In anhydremia of short duration the blood volume may be replaced by generous administration of fluids but when of long standing the reparation process is slower and the normal volume is not restored until the blood cells (a certain number of which are destroyed in prolonged desiccation) and the serum protein are restored to normal proportions. This is best done by blood transfusion which in this group of cases is attended by most satisfactory results.

In addition this group must have careful individual attention. They chill easily and are especially prone to respiratory infections. They must be kept warm. Food must be appetizing and abundant. Fluid intake must be kept at a high level.

SPINAL ANESTHESIA

LINCOLN F SISE

WHILE spinal anesthesia is used considerably by a few men, it is not used by as many surgeons and anesthesiologists as it might be. In this clinic while the actual number of cases in which it has been used is small yet in these cases it has filled a need which it would have been difficult to meet so satisfactorily in any other way.

ADVANTAGES

It has practically no deleterious action on most of the important vital centers—the lungs, kidneys, and liver, and little but a secondary effect upon the heart. Metabolic equilibrium is not disturbed. Relaxation is excellent. Recovery is prompt and usually unattended by nausea and vomiting. Consequently, liquids and frequently food need not be restricted for as long a period as after an inhalation anesthetic. The general upset to the patient following operation is strikingly less than it is after an inhalation anesthetic.

It has also certain advantages over other forms of regional anesthesia. The technic is fairly easy and simple and with slight modifications is applicable to a wide range of operations over a large portion of the body. Thus it can be learned and used by men who have not the time, the opportunity, or perhaps the aptitude to learn the numerous and more intricate procedures necessary for the same operations when other forms of regional anesthesia are used. Its induction is less painful to the patient than is that of many of these other forms. In many cases both anesthesia and relaxation are better.

DISADVANTAGES

It is very generally believed that there is more danger to this form of anesthesia than to the more commonly used gen-

eral anesthetics. The rates given by different observers are higher. There are reasons however why it is unfair to compare these rates with those for the general anesthetics.

1 Spinal anesthesia is frequently used where the condition of the patient is such that for one reason or another a general anesthetic is considered dangerous. In this clinic at least it is used mainly where there is some decided objection to a general anesthetic where the condition of the patient is such that a general anesthetic appears to be more dangerous than spinal anesthesia.

2 Much of the reported mortality of spinal anesthesia has been with drugs and methods much inferior to those of today. Only recently has the mechanism been clearly understood of the drop in blood pressure so frequently seen and only recently has an effective treatment been developed for this. And finally it may be said that most really effective agents or methods are not free from danger if used improperly.

Another disadvantage of this method is that there is occasional failure to get anesthesia high enough or even to get any anesthesia at all. The failures given by different observers vary from about 1 to about 6 per cent. The length of the anesthesia is limited, varying chiefly with the amount of the drug used. The retention of consciousness is also a disadvantage with most patients but if necessary this can be overcome by giving a light gas anesthesia just enough for loss of consciousness.

The after effects are usually slight at most. With proper technic they are less than after most general anesthetics.

MATERIALS

Quite a number of different drugs have been used the chief ones being novocain, stovain, tropacocain and apothesine. We believe novocain to be the best of these largely because where pure novocain is used there appear to be fewer unpleasant after effects than where any of the other drugs are used.

The needle should be made of nickel. Steel needles are subject to rust and may break off between the vertebrae during an injection. Platinum iridium is too soft to take a good point. A sharp point is very desirable so that the hole in the dura

shall be clean and small, so as to close easily. A dull needle may tear a rent. The nickel needle is rustless, will not break, and takes a fairly sharp point. The bevel of the point should be short so that when the bevel is just entirely within the membrane the end of the point will still be not too far in. The length of the needle should be about $3\frac{1}{2}$ inches. The gage most commonly used is 17 to 18 Stubs' English wire gage. We are using with great satisfaction a finer needle, No. 19, Stubs' gage. A smaller gage even than this may be used. The small gage needle is less painful to the patient, requires less force to introduce it, lessens the possible force of the injection, and makes a smaller hole in the dura. Its only objection is its lumberiness. This makes it more difficult to guide the needle during its introduction and makes it necessary to grasp the shaft with the fingers in order to keep it from bending. There is also needed a 20 c c glass syringe to fit the needle, and a small glass beaker in which to dissolve the novocain. An ordinary hypodermic needle may be used to anesthetize the skin for the puncture and for subcutaneous medication should it be necessary. Apparatus for the intravenous injection of salt solution completes the outfit, and should be sterilized, ready for immediate use when the anesthesia is started.

TECHNIC

Surgical asepsis is used throughout. It seems possible that some of the unpleasant sequelæ noted in the past may have been due to low grade infection. For the skin we scrub twice thoroughly with ether and then use half strength tincture of iodine. In boiling the instruments care should be taken that no bicarbonate of soda is used in the water. A rubber glove is used for the right hand, so that the bare fingers shall not come in contact with the shaft of the needle. The syringe, needles, and beaker are all rinsed in sterile distilled water.

The introduction of the spinal needle is done with the patient in the sitting position, or, if he is unable to sit up then with him lying on one side. The important point in his position is that the back be well arched so that the spinous processes are separated as widely as possible. He should sit across the operating

table as far back as possible so that the knee comes at the edge of the table. The feet should be supported by a stool and an attendant should stand in front of him to steady him and see that the back is kept well arched.

While the skin of the back is not highly sensitive so that local anesthesia for the puncture is not absolutely necessary yet it is a good plan to make a wheal in the skin with novocain at the site of puncture. Puncture of the skin is a little more painful without the wheal and this fact makes the patient more apprehensive and less likely to co operate well in arching the back.

LANDMARKS

A line drawn between the crests of the ilia will usually cross the spine at the spinous process of the fourth lumbar vertebra or just below it (Fig 235). In palpating the ilia in fat people due allowance should be made for the thickness of fat which may be rolled up over the crests. A convenient method of palpating the ilia without breaking asepsis is to fold a towel lengthwise place the hands within the fold and palpate so that one side of the towel is between the hands and the patient the other side falls back over the hands and the edge is used as the line between the crests (Fig 236). If care is taken and the edge is manipulated so that it is straight and its ends are just on the crests this method is quite accurate. Having determined which spine is the fourth it is easy to count from this to any desired space.

We usually make a practice of checking this procedure by finding the twelfth dorsal spine according to the method recommended by Labat. To do this palpate the twelfth rib and find on it a point 5 cm from the midline. If this 5 cm is perpendicular to the midline the point where it reaches the spine will be the spinous process of the twelfth dorsal vertebra (Fig 235). If the spinous processes do not coincide when found by these two different methods an error has probably been made and the two procedures should be repeated until each checks the other as being correct.

The Puncture—There are two methods by which puncture may be made. (1) With the thumb and forefinger make the

skin tense over the selected interspace and puncture the skin in the midline half-way between the two spinous processes.

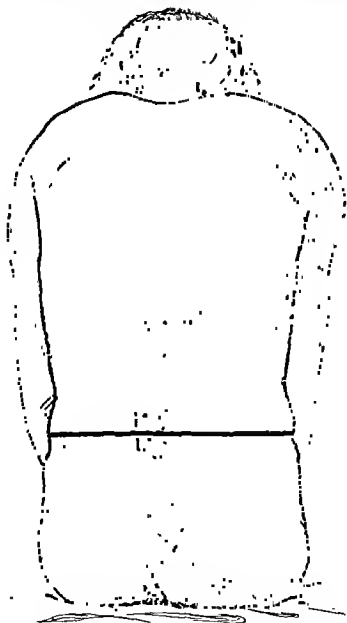


Fig 235 —Landmarks for determining spine. Dark line is at height of iliac crests.

When the skin has been punctured, verify the position of the needle before advancing it to the deeper structures. Then

advance it exactly in the median line at right angles to the plane of the skin of the back. If puncture is unsuccessful and bone is encountered, the needle should be largely withdrawn and reinserted, pointing very slightly upward. If this, again, is unsuccessful, it should in the same manner be pointed slightly downward. Or it may be withdrawn so that the point is engaged

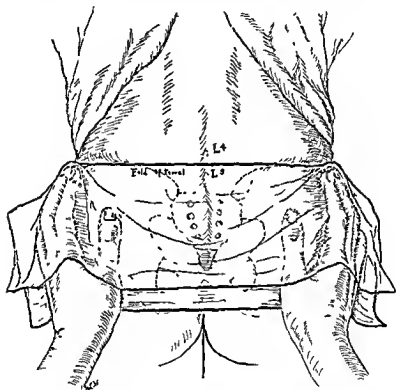


Fig. 236 — Method of palpating iliac crests while sterile

in the skin alone, and the skin then pulled down slightly so that puncture is made a little lower, when the needle should be slanted up slightly. By manipulations of this sort puncture is rarely unsuccessful. If still unable to enter, success may sometimes be had by the second method of puncture.

(2) Select a point $\frac{1}{2}$ inch to one side of the midline and on a level with the superior edge of the spinous process below the

interspace selected. Again make sure of the position of the needle after piercing the skin. Then advance it slightly upward and inward so that the point shall be in the midline at the time the spinal canal is tapped. In making each puncture the stylet of the needle should be in place. As the ligamentous subflavum is pierced the resistance decreases considerably. Advance now very slowly and gently till a slight snap is felt. On withdrawing the stylet spinal fluid should flow. If at any point difficulty is experienced, make sure that the patient's back is still well arched.

Sometimes when fluid is obtained the flow is very slow and if a syringe is attached to the needle and suction made, it stops entirely. This is probably due to a flap of the dura over the end of the needle, which closes like a valve when suction is used. The needle may then be rotated or advanced a little or withdrawn a little to clear the opening of the needle from the obstruction. When a free flow is once established, great care should be used to see that the needle does not move in the slightest from the correct position. The needle may be held in the fingers of the left hand with the wrist steadied against the patient's back. Withdraw the desired amount of cerebrospinal fluid into the syringe, but stop immediately if at any time headache appears. The novocain, previously placed in the glass beaker, should now be dissolved in the spinal fluid. It is essential to see that it is dissolved thoroughly and mixed uniformly with the entire amount of fluid. When the syringe is filled with this solution and has been attached to the needle it is well before injecting to withdraw a very little fluid to make sure that no air, which might be injected, has remained in the needle. The injection should be made quite slowly. Forcing the fluid tends to send it higher. Two or three times in the course of the injection it should be stopped and a little fluid withdrawn in order to be sure that the needle is still in the correct position. With the injection finished the needle is quickly withdrawn, the puncture sealed with collodion, and a firm sterile dressing applied. The patient may later be moved about on his back, so that if this dressing is not quite firm it may be torn off.

Up to a certain point the length of the anesthesia varies with the concentration of the drug which is brought in contact with the nerves. Thus it varies directly with the amount of the drug used and inversely with the extent of the anesthesia. It lasts ordinarily from three quarters of an hour to an hour and a half most commonly about an hour. In one case of ours it lasted but twenty minutes, while in another case it lasted well over two hours and was sufficient for the complete operation, abdominal and sacral, for carcinoma of the rectum.

HEIGHT OF ANESTHESIA

The height of the anesthesia is dependent on a number of different factors, chief of which are the site of the puncture, the force of injection, the amount of fluid withdrawn, the effect of gravity and to some extent the amount of the drug used. These factors are used in different ways by different men in getting the desired height of anesthesia.

The method of which Jonnesco has been the chief exponent depends mainly on the site of puncture. This has the great advantage both that the area anesthetized may be limited more strictly to the field of operation and that it may even be limited to some extent to the posterior roots, so that the anterior roots, which contain vasomotor control, are not deeply and completely blocked. Thus by this method there is apt to be less vascular depression than by the methods of diffusion. But a serious objection to this method is that the cord is more liable to injury than where the puncture is made always in the lumbar region. The cord ends usually at the level of the first lumbar vertebra though occasionally it may reach as far as the lower border of the second. Thus if puncture is made below this latter place, the cord itself will be safe. Punctures above this point can, of course usually be made without injury as the point of the needle is stopped in the subarachnoid space before the cord is reached. But, unfortunately, the subarachnoid space is occasionally absent because the arachnoid membrane is adherent to the cord along its posterior surface. Thus when puncture is made the needle on piercing the arachnoid will go directly into

the cord. If fluid is withdrawn it may come from in front of the cord after the needle has gone entirely through the cord. It seems to us therefore, safer to make the puncture always in the lumbar region and get the desired height in another way. The method outlined here has given satisfactory results in our hands.

The site of puncture is the second lumbar interspace for all operations above the groins. The third interspace may be used for thigh operations and the fourth for operations on the leg or perineum.

We have not used force in making the injection in order to gain height. It has seemed to us that it would be difficult to measure the amount of force and that the control of diffusion in this way would be uncertain.

We have found the amount of fluid withdrawn to be the most satisfactory manner of determining the height of anesthesia. In addition to regulating the height of anesthesia, the dilution of the drug which necessarily accompanies this method makes also for safety. Where a dilute solution is injected, it is fixed more readily in the tissues and there is not so apt to be an excess left over after fixation which might, with a change of position of the patient, be gravitated toward the vital centers in the medulla. The larger the amount of fluid withdrawn, the higher is the anesthesia. One cannot make an exact scale of height for certain amounts withdrawn because this varies somewhat with different individuals. But in general we have found that with men when the injection is made in the second lumbar interspace, if 10 c c is withdrawn, the anesthesia will reach to the groins, 15 c c, to the umbilicus, and 17 or 18 c c, to the epigastrium or midchest. One should stop the withdrawal of fluid immediately on the appearance of headache. This, however, is quite unusual.

The larger the amount of the drug, the higher is the anesthesia. The effect of different quantities of the drug, however, is not marked in this respect. The greatest effect is seen in the depth and length of the anesthesia.

We buy the drug in crystallized form a measured dose, steril-

ized in a sealed ampule ready for use. In general the dose is made to equal approximately 10 mg. for each 15 pounds of body weight. The usual minimum dose however is 100 mg.

In a few small and weak individuals this is reduced to 90 or even 80 mg. in certain instances. For a very low anesthesia as little as 60 mg. may be used successfully. The maximum dose for any individual is 120 mg.

CONDUCT OF THE ANESTHESIA

As soon as the injection is completed the patient is immediately laid flat upon the table. The head may be raised upon a pillow, but it is illogical to raise the shoulders in addition. The reverse is more apt to be necessary. Consequently shoulder pieces should be put in position ready for immediate use. Where the method here described is used it seems quite certain that the patient can be put in Trendelenburg position immediately after the injection is made without danger of the drug gravitating to the higher nerve centers. But unless there is some good reason for the immediate assumption of this position it is more conservative to wait till the drug has had time to become fixed in the tissues. This is probably accomplished in a very few minutes, ten at the most, when it is absolutely safe and usually beneficial to incline the head of the table downward. A hypodermic syringe for adrenalin and apparatus for the immediate administration of salt solution should be sterilized and ready.

It is very essential during anesthesia that a careful watch be kept upon the patient. The blood pressure especially should be watched, but the respiration should not be neglected. The breathing of these patients is usually quiet and shallow, and unless attention is paid to it it is perfectly possible for it to stop without this fact being noticed.

Anesthesia usually sets in from four to ten minutes. This may now be tested for by the prick of a pin. When the operation is finished and the patient is moved to bed he should be treated very gently and care should be taken that he is not jarred in being transferred from one place to another. In all except the

lower anesthetics, the patient should be kept flat in bed until recovery from the anesthesia begins to take place and vasomotor control is re-established. Any raising of the upper portion of the patient's body before this time may induce syncope which may prove fatal.

Anesthesia starts in the perineum and feet and progresses rapidly up the body until near the height which it will eventually reach, when it progresses more slowly. In the higher anesthetics, roughly, those above the groins, a certain amount of drop in blood-pressure is usual. Where this occurs the patient presents certain characteristic phenomena—pallor, sweating, thirst, sometimes nausea, and frequently a certain amount of mental dulness. Watch carefully the patient who is very quiet. The reason for this drop in blood-pressure is a paralysis of vasomotor control, particularly control of the great splanchnic pool. The anesthetic paralyzes not only the nerves of sensation but also the motor and vasomotor nerves. Fortunately, these motor nerves are affected less deeply than are the sensory nerves. The vasoconstrictor fibers emanate from the cord in the region between the level of the second dorsal and that of the third lumbar spinal roots. The great splanchnic pool is controlled by the region from the sixth dorsal to the third lumbar. Consequently, practically all of these vessels are relaxed in an anesthesia extending to the ensiform cartilage, and a pronounced drop in blood-pressure is usually apparent. This drop is usually accompanied and probably accentuated by a slowing of the heart rate. It is possible that this slowing may at times be produced at least in part by blocking of the upper dorsal nerves.

The anterior roots of these nerves convey sympathetic fibers to the heart which normally oppose the action of the vagus, so that their partial or complete blocking may leave the vagus partly or wholly free to exert its slowing action on the heart.

Young patients are less affected by this drop in blood-pressure. The older patients, and those with arteriosclerosis, are usually affected the most severely. The effect of a given degree of vascular depression varies with different individuals, but in general if the drop in pressure does not reach below 90

mm systolic blood pressure, it is considered quite satisfactory. If it reaches to 50 or 70 mm, mild measures may be instituted. If it reaches to 30 or 40 mm, effective treatment should immediately be instituted.

TREATMENT OF DECREASED BLOOD PRESSURE

In the treatment of the milder degrees of depression one may resort to the following measures:

- 1 The table may be tipped so that the head of the patient is lowered. This is one of the quickest and easiest things to do. The table may well be put into an extreme incline. Many have objected to this procedure on the ground that the novocain might gravitate to the respiratory center and cause failure of respiration. With the technic outlined, however, the novocain is so diluted and is taken up by the tissues so promptly that there is no danger of this accident happening. We have used this position repeatedly and have operated on patients in Trendelenburg position and have never seen any but beneficial effects from it.

- 2 The inhalation of carbon dioxide to the point of moderate stimulation of respiration or the inhalation of ammonia or ether gives mild stimulation. We have not used ammonia or ether, but have had very good success with carbon dioxide.

- 3 Five to 10 minims of adrenalin may be injected subcutaneously. This gives somewhat greater and more prolonged stimulation. Care should be exercised that the adrenalin is not injected into a vein. If the whole dose were injected directly into the blood stream excessive stimulation would ensue, with later corresponding depression.

- 4 Oxygen especially in conjunction with carbon dioxide may be given by inhalation. While oxygen is not in itself a stimulant yet it is very beneficial where depression of circulation and respiration have reduced greatly the oxygen carried by the blood.

While these methods are effective for the mild degrees of depression they are not sufficient for anything very severe. For severe depression we believe the method advocated and so

clearly set forth by Babcock is the really efficient one. The drop in blood pressure is caused by a paralysis of the nerves conveying vasomotor impulses from the cord outward. It is impossible therefore to accomplish anything by central stimulation. The action must be peripheral. Adrenalin produces vasoconstriction by peripheral action and is therefore still effective even though the vasomotor fibers leading from the cord are blocked by our spinal injection. Moreover its greatest effect is exerted in the splanchnic area where it is most needed and there is apparently no effect on the coronary arteries so that the blood supply of the heart muscle is not reduced. Thus it would appear that adrenalin might very nearly reverse the action of our spinal block on the circulation and that it would, therefore, be an almost ideal drug for treatment of the lowered blood pressure.

The results of treatment must be secured immediately. Therefore the adrenalin must be placed directly in the circulation. At the same time, as its action is but short lived, this action must be continued by means of repeated small doses. In practice the best way to do this is by means of intravenous salt solution to which adrenalin is added as needed. The needle of a hypodermic syringe filled with adrenalin may be thrust into the rubber tubing of the intravenous salt solution apparatus close to the needle in the vein so that any adrenalin injected is immediately carried into the circulation by the salt solution. One to 3 minims at a time may be added as needed to produce a moderate continued stimulation and to maintain the blood pressure at about 80 or 90 mm systolic. We know that the vasomotor paralysis induced by the novocain will wear off in a comparatively short time and that the patient will then be all right. All that is necessary is to tide him over this period. This the adrenalin is well fitted to do.

Respiratory Failure —This is a complication which has been much talked of as being due to paralysis of the respiratory mechanism caused by too high diffusion of the drug in the spinal canal. Such a paralysis has probably taken place in a few cases. It seems highly probable, however, that in most of the cases res

piratory failure has been secondary and due to lowered blood pressure and not to a direct action of the drug on the respiratory center. In an anesthesia extending to the epigastrium we need to get only as high as the seventh dorsal nerve while to get direct paralysis of respiration we would have to anesthetize the third fourth and fifth cervical nerves. In operations on the lower abdomen therefore there is a considerable margin between the anesthesia necessary for the operation and that which might produce paralysis of respiration. Moreover a very deep anesthesia of the cervical nerves is necessary to paralyze the respiratory functions as their sensory portions have been well anesthetized without producing paralysis of respiration. The usual treatment therefore of respiratory failure resolves itself into that of lowered blood pressure. Of course artificial respiration must be resorted to if respiration actually ceases whether the failure be due to lowered blood pressure or to actual blocking of the nerves of respiration.

Incontinence of Feces—This is not infrequent with a profound anesthesia if there is anything in the rectum. Therefore it is well to see that cathartics and enemata are given long enough before operation so that the rectum shall be empty. This is particularly important in pelvic operations where the patient is in the Trendelenburg position and especially so in abdominal hysterectomy as the feces might then flow up through the vagina into the abdominal cavity.

Nausea—This may be caused during the anesthesia by a sudden drop in blood pressure it may be psychic or in abdominal operations it may be due to pressure of packing toward the epigastrium. The treatment would be that appropriate to the condition causing it.

AFTER EFFECTS

These are usually slight or absent if proper technic is employed. One of the great advantages of this method of anesthesia is the absence of after effects. The incidence of after effects is reduced by first using novocain second a pure drug, third scrupulous asepsis fourth the absence of any foreign body

in the fluid injected. This is accomplished by rinsing in distilled water all the instruments used, by using spinal fluid to dissolve the drug, and by taking care that no bubble of air is introduced during the injection, fifth, by a correct puncture. The wound in the dura should be clean, such as is made by a sharp needle, should be in the median line, and below the second lumbar vertebra.

The most common after effect is headache. This appears a few hours to a day after anesthesia. It usually yields to quiet and aspirin, but may be quite severe and persistent. Insomnia is next in frequency. There may be temporary and mild paralysis. Abducent paralysis of the eyes is the most frequent.

INDICATIONS

Spinal anesthesia may be used in any operation below the umbilicus and frequently to advantage. It is indicated in such operations when there is some reason against the use of other anesthetics. We have used it especially in suprapubic prostatectomy and in second stage carcinoma of the rectum. The fact that there is little or no interruption to the taking of liquids is of great value in prostatectomy. We have also used it, and always with good success, in operations on the pelvic organs when some condition, such as age, vascular disease, or lung complications, made a general anesthetic inadvisable. As the sympathetic fibers to the stomach and intestines are partially or completely blocked, the inhibitory action which they normally oppose to the vagus is lessened or removed and the stomach and small intestines are contracted and peristalsis is increased. This condition together with the excellent relaxation of the abdominal walls, makes this anesthesia very favorable for the work of the surgeon in abdominal operations. In operations on the legs or perineum the indications may be made more liberal, as the drop in blood pressure experienced with the higher anesthetics is in these low anesthetics very slight or absent. For these latter operations it therefore seems to us a decidedly safe method of anesthesia.

CONTRAINDICATIONS

While this method of anesthesia has been used for operations in all parts of the body yet in general its danger increases directly with its height and few men have felt like using it in operations above the abdomen. While upper abdominal operations may well be performed under this anesthesia we feel that the indications for it should be quite strict. Thus far we have limited ourselves almost entirely to operations below the umbilicus. Operations above this point besides being more liable to a severe drop in blood pressure have the additional disadvantage that the Trendelenburg position the most favorable position for the anesthesia is unfavorable for the surgery.

Low blood pressure is a contraindication which increases in force with the height of the anesthesia contemplated. A systolic blood pressure of 110 mm. would be against a spinal anesthesia of such height that a drop in blood pressure would probably ensue but would not necessarily prevent a low anesthesia of the leg or perineum where any appreciable drop in pressure would be quite unlikely. Spinal anesthesia should not be used in a condition of shock or in any other condition in which low blood pressure is likely to ensue apart from the anesthesia. Considerable caution should be exercised in deciding to use it in the presence of myocardial degeneration as in this condition the heart muscle may not bear well any considerable drop in blood pressure. It is contraindicated in active syphilis. It is unsuitable in long operations as the anesthesia may wear off before the end of the operation. Usually a length of about one hour for the anesthesia can be relied upon.

SUMMARY AND CONCLUSIONS

Spinal anesthesia is a form of anesthesia which for operations on the leg or perineal region is decidedly safe and for operations as high as the umbilicus is in certain cases safer and better than other anesthetics.

Its chief danger is its effect in lowering blood pressure. This effect can be largely guarded against by proper selection of cases and by proper technic and can be remedied by proper treatment.

MASSIVE ATELECTASIS

ROBERT L. MASON

SINCE 1914 when Pasteur called attention to the not infrequent occurrence of collapse of the lung after major surgical operations case reports of this postoperative sequel have been increasingly numerous. The following case, however, is so typical and illustrative of several features of the condition that its presentation here appears warranted.

REPORT OF CASE

Mr F. D., aged eighteen, white, a machinist by trade, was admitted to the clinic for repair of bilateral inguinal herniæ. One week before entrance while lifting a heavy weight, he had experienced a pain in his right groin. On investigation a reducible mass the size of an orange was discovered in the scrotum, where it had remained except when reduced by manipulation.

His family history was negative, as was also his past history. He had had most of the children's diseases without sequelæ. He had had no colds or history of upper respiratory tract infection during the preceding year.

Physical examination showed a well developed young man of eighteen in apparently excellent general condition. There was a scrotal hernia on the right and a small indirect hernia on the left.

On November 21st repair of the herniæ was done. Anesthesia was by nitrous oxid-oxygen ether sequence, with open ether maintenance. Throughout anesthesia there was but very little mucus. The operation itself was without particular incident.

Aside from urinary retention during the first twenty four hours requiring catheterization, the initial operative recovery was uneventful. There was a moderate amount of pain in the left groin which was relieved by codein. On the evening of November 23d fifty five hours after operation the patient's condition showed a definite change. He stated that he had suddenly



Fig. 237—On the left side but a small amount of lung tissue is seen at the apex. The heart shadow and diaphragm are obscured. Note marked displacement of trachea and mediastinum to the left.

felt suffocated. The feeling of suffocation was followed by dyspnea and a dull pain beneath the xiphoid. There was a dry, unproductive cough. The temperature, which previously had ranged around 99° F, was found to be 103° F, the pulse rate had risen to 120, and respirations to 48. Any movement in bed resulted in accentuation of the dyspnea and brought on

paroxysms of coughing. There was slight cyanosis. He appeared critically ill.

The left side of the chest appeared immobile and definitely flatter than the right. Auscultation and percussion were somewhat unsatisfactory because of the difficulty in moving the patient. Anteriorly there was dull tympany up to the fourth



Fig. 238—Taken thirteen hours after Fig. 237. The heart outline can be made out and also some of the diaphragm. Two thirds of the lung is clearing. (This has been reversed in reproduction.)

rib, above this there was dullness. Posteriorly the whole left side was dull. There was distant bronchial breathing throughout the left chest. Breath sounds were distant and tactile fremitus diminished. There were no râles. The right chest was somewhat hyperresonant. The outstanding feature of the examina-

tion however was the marked displacement of the heart upward and to the left. The apex impulse was seen and felt in the third space left midaxillary line. The heart sounds were best heard in the second space midclavicular line where a slight thrill could also be felt. There were no murmurs. Due chiefly to the marked cardiac displacement a diagnosis of massive collapse was made and corroborated by x ray (Fig. 237).



Fig. 239—Nineteen hours after Fig. 237. The lung markings show some increase and the heart outline is becoming more characteristic.

About six hours after the onset the cough which heretofore had been dry, became productive of a considerable quantity of thick tenacious greenish purulent appearing sputum. From this time on the patient experienced marked subjective improvement. During the subsequent six hours the temperature dropped from 103° to 99.2° F, the pulse to 96 and respirations to 30.

At this time the apex impulse was felt in the fourth space, left anterior axillary line. Figure 238 shows the change that had taken place since the preceding x ray examination at the onset of the collapse thirteen hours before.

Another plate (Fig 239), taken six hours later shows still further progress toward normal. Figure 240 taken November



Fig 240—Forty hours after Fig 237. The heart is coming back to its normal position and the diaphragm can be seen.

25th forty hours after onset shows the heart coming back to its normal position. There is still some density in the central portion and toward the base.

By the end of seventy two hours the heart, by percussion, had returned to its normal position. There were a few crackling

râles at the angle of the left scapula; otherwise the physical signs were not abnormal

Temperature, pulse, and respiration showed slight upward excursions until the fifth day after onset of the collapse. Subsequently all were normal. The cough and production of sputum also diminished gradually and had disappeared by the fifth day.



Fig. 241—Fourteen days after onset of collapse

Figure 241 shows the condition of the chest two days before discharge, fourteen days after the onset of the collapse

Churchill in a recent discussion emphasizes the fact that the condition known as massive collapse is, in reality, but a special manifestation of pulmonary atelectasis. As such it is believed to result from the same etiologic factors as atelectasis occurring in other clinical entities. Of these etiologic factors, the two most

important are weakened respiratory force and bronchial obstruction.

Most cases of massive atelectasis occur following major abdominal operations. In most of these the respiratory excursion is shallow, due to pain, and there is an increased amount of secretion from the mucous membrane of the respiratory passages. The patient refrains from coughing in many cases on account of the pain incident to the strain on the wound, and bronchial secretion is apt to accumulate. Theoretically at least the combination of these factors could easily bring about atelectasis.

In the case reported it is interesting to note the prompt improvement which followed the raising of a quantity of thick tenacious sputum about six hours after onset. Conceivably with the raising of this sputum the occlusion of the bronchus was released, with partial re-expansion of the collapsed lung.

The onset of the symptoms may occur at any time following operation up to the seventh day. Most cases occur, however, during the first seventy-two hours. The duration is variable, but in most cases the condition clears up within a few days. The prognosis is invariably good in typical cases. It is, of course, possible that many postoperative pulmonary complications of longer duration and with less favorable prognosis have their origin in an area of atelectasis, undetected as such, which later becomes the seat of an infarction or an infection.

The symptoms and the physical signs noted in the case reported are typical. The outstanding physical sign is the marked displacement of the heart and mediastinal contents toward the affected side. This sign, together with the sudden onset of respiratory distress and physical signs suggestive of consolidation, should lead one to make a presumptive diagnosis of massive atelectasis. The x-ray is corroborative and portable plates should be taken as soon as the condition is suspected. The differential diagnosis is, of course, between an inflammatory process of the lung or pleura, or an infarction. Here again the marked displacement of the heart and mediastinal contents toward the affected side is the differentiating factor. A correct diagnosis is important both from the standpoint of prognosis and

in order to avoid misdirected diagnostic or therapeutic measures such as thoracentesis

There are no specific therapeutic measures in massive atelectasis beyond general supportive treatment and removal of any obstacle to free respiratory excursion. Binders should be loosened in order that the respiratory muscles may have full play. A high head rest facilitates breathing. Morphine should be given to control pain incident to the operation. After improvement has begun, blow bottles are of use in promoting re-expansion of the lungs.

DIVERTICULA OF THE ALIMENTARY TRACT

SARA M JORDAN AND FRANK H LAHEY

THERE occurs occasionally in all hollow viscera, alimentary tubes blood vessels gall and urinary bladders an abnormality which arises from a protrusion of all or part of the wall, and in the blood vessels is called aneurysm in the other organs is called a diverticulum. Such 'preternatural pockets' were found at autopsy in the esophagus by Ludlow in 1764 and in the duodenum by Chomel in 1707. With the exception of rare surgical findings diagnosis of diverticula of the gastro-intestinal tract from pharynx to rectum was made only on the autopsy table until 1912 when x ray made it possible to identify and locate such abnormalities. In the spirited discussions which have been conducted throughout many years as to the origin and development of these pockets three questions have received most attention.

1 Are these diverticula true or false?

2 Are they congenital or acquired?

3 Are they pushed from within outward because of some inherent weakness in the muscular coat, or drawn from without through some inflammatory process external to the tube, in other words are they pulsion or traction diverticula?

The distinction between true and false diverticula was based upon the supposition that a pocket without a muscle coat was simply a protrusion of the mucosa through a hiatus in the muscle layer. With more extensive studies of the histology of these diverticula it was noted that though the muscle layer was usually thinned out by distention of the sac, it was present immediately about the neck of the sac which in its origin, therefore, contained all layers of the normal intestinal wall.

The matter of congenital or acquired origin became of interest when it was noted that most cases having symptoms referable to diverticula were of middle or advanced age. Why

should a supposedly congenital deformity cause trouble only in mature life? The answer to this question now practically unanimous is that such a diverticulum represents a congenital weakness in the wall of the tube to which is added pressure from some cause within resulting in the sac like projection of the wall. Another variety of diverticula was identified and distinguished from this last type, namely, the so called traction diverticula, produced by an inflammatory process which adheres to the wall of the tube and draws out a small portion of that wall in the form of a sac. A classification of diverticula into traction and pulsion types was then made.

It was at first thought that diverticula of the various parts of the gastro intestinal tract were distinct entities but numerous autopsy observations of multiple pockets in several parts of the alimentary canal and even in the urinary bladder made it clear that in some individuals there exists a tendency to diverticular formation, which was then termed "*la maladie diverticulaire*" or diverticulosis.

Clinically the points of chief interest in diverticula are the facts

- 1 That these pockets are rounded or oval structures attached to and opening into the alimentary tube

- 2 That the contents of the gastro intestinal tract from the stage of undigested food to that of feces may enter and be retained in such pockets

- 3 That symptoms may arise

- (a) From pressure of a filled sac on the tube itself or upon adjacent structures

- (b) From retention of the contents of the sac with irritation and inflammation

- 4 That except in the esophageal portion of the tube it is difficult to ascribe symptoms solely to the presence of diverticula

- 5 That the logical treatment of such abnormalities is their resection

- 6 That resection of the sac is often impossible because of its location and that from the point of view of therapy, therefore, the location of the sac is of prime importance

It is our intention to discuss the diverticula of the various divisions of the alimentary tube with reference to these clinical points of interest.

ESOPHAGEAL DIVERTICULA

Zenker and von Ziemssen were the first to classify diverticula of the esophagus into the traction and pulsion types. The traction type, funnel-shaped, with the apex directed outward



Fig. 242 —Showing esophageal diverticulum of the traction type

and usually upward, rarely harbors accumulations, and therefore rarely causes symptoms. Located, as they are, within the pleural cavity, they can be treated only by dilatation with bougies (Fig. 242).

The pulsion type, described accurately in 1764 by Ludlow and in 1816 by Bell, occurs at the pharyngeal dimple (Fig. 243)

on the posterior wall of the esophagus. Presumably these pockets are produced by a rise in intrapharyngeal pressure due to a failure of the fibers of the inferior constrictor muscle to coordinate with the muscles above in the propulsion of the bolus of food downward. The intrapharyngeal pressure results in a protrusion of the mucous membrane through the pharyngeal dimple (Fig. 244) usually to the left of the esophagus, between the pretracheal and deep cervical fascia into the superior medi-

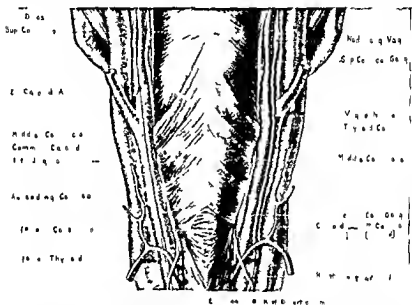


Fig. 243.—Drawing of dissection made under our direction to show location of neck of diverticulum at the pharyngeal dimple the junction of transverse and oblique fibers of the cricopharyngeus muscle

astinum when the diverticula become sufficiently large to reach this point

The chief symptom of esophageal diverticula is dysphagia which progresses from a slight discomfort in swallowing, with dryness and scratchy sensation and expectoration of mucus, to the real difficulties occasioned by the sticking of food particles, at first large solid particles later small semisolid ones. Finally, even liquids are swallowed with difficulty. Pressure of

the filled sac and closure of the esophageal opening with its conversion into a slit like orifice are the causes of obstruction. Regurgitation of undigested food without hydrochloric acid and foul breath usually attend this condition. Indirect results of



Fig. 244—x Ray of pharyngo esophageal diverticulum—puls on type

pressure may be seen in the dyspnea cyanosis or hoarseness which occur in those patients who have large distended sacs.

The treatment of pharyngo-esophageal diverticula consists

- 1 Of dilatation with esophageal bougies
- 2 Of surgical removal of the sac

Dilatation is frequently adequate in the earlier stages of diverticular formation but eventually surgery becomes imperative.

The early history of the surgical treatment of pharyngo-esophageal diverticula was very far from brilliant. Suture of the esophagus following amputation of the sac was often followed by leakage which owing to the anatomic location of the sac beneath the deep cervical fascia found its way down into the mediastinum produced a deep cellulitis mediastinitis and eventually resulted in death in a high percentage of the cases. Means to overcome this distressing complication were devised such as Bevan's inversion of the sac and freeing and fixation so that its apex was located higher than its opening into the esophagus thus preventing dilatation and accumulations within it. These measures however were not satisfactory and it was not until the two stage removal of the sac was employed that surgery of the pharyngo-esophageal diverticula offered an outlook for the patient that was at all pleasant to contemplate. In the two stage removal the first stage consists in freeing the sac implanting it upon the skin of the neck and then suturing the skin and muscles of the neck. The second stage consists in removal of the sac after the wound is healed. By means of this procedure we have operated upon six pharyngo-esophageal diverticula all safely and with satisfactory outcome.

The operation is readily accomplished under local anesthesia. The upper pole of the thyroid gland is found and turned inward and the external wall of the esophagus is then found presenting just behind the laryngeal cartilage. The sac of the diverticulum which is usually located on the left with its neck opposite the level of the cricoid may be readily located and by gentle traction upward together with careful dissection may be elevated from its position in the mediastinum and freed from its loose surrounding attachments until it hangs by its neck at its point of origin. The muscles and skin may then be caught to the neck of the sac by a few stitches and the skin wound closed about the neck the sac being left upon the neck in some boric ointment gauze. At the end of ten days no anesthetic being neces-

sary, the sac may be cut away, the mucosa snipped off from the canal as deeply as possible, and the resulting opening plugged with a little boric ointment gauze. The wound is then allowed to close, which it usually does in a week or ten days.

The simplicity and safety of this procedure is most gratifying. Following the placing of the sac in the dressings and the fixation of its neck to the skin, the patient is immediately able



Fig 245—r-Ray of beginning recurrence of esophageal diverticulum in patient who had no postoperative dilatation

to swallow with the same freedom he enjoyed previous to the onset of his difficulty.

Writers upon this subject have laid little stress upon the factors leading to the production of pharyngo esophageal diverticula and still less upon the necessity for carrying out prophylactic measures against a possible return. From experience with our first case, we wish to urge that postoperative dila-

tations of the esophagus be routinely employed for some time following operation and that occasional bismuth x rays of the esophagus be taken in order to be sure that the diverticulum is not returning for it should be remembered that removal of the sac of the diverticulum does not rid the individual of the factors that produced it. It is for this reason that we now advocate repeated postoperative dilatations of the esophagus.

Figure 245 shows the beginning return of a diverticulum in our first patient who had had no postoperative dilatation. When returned for follow up he complained that he was again beginning to have the early or prodromal symptoms of pharyngo-esophageal diverticulum namely a scratching in his throat a sensation of particles sticking there and hawking. All of these disappeared as soon as several metal olive bougies were passed beyond the first portion of his esophagus.

GASTRIC DIVERTICULA

The autopsy reports of pulsion diverticula of the stomach are very rare. Keith in 1910 reported 2 cases at the cardiac



Fig 246 —x Ray of stomach with diverticulum just below cardiac orifice

end of the stomach, apparently of the pulsion type, and a few cases have been reported in which pockets containing pancreatic cells were found at the cardiac and one at the pyloric end of the stomach. E. S. Emery¹ reports 2 cases diagnosed by x-ray in which a diverticulum was found just below the cardiac orifice. Undoubtedly such cases will be found more and more



Fig. 247—x-Ray showing six hour residue in gastric diverticulum.

frequently as fluoroscopic technic is improved. Figures 246 and 247 illustrate cases of gastric diverticula found by Dr. L. B. Morrison, roentgenologist to the New England Deaconess and the New England Baptist Hospitals, in which the symptoms of substernal burning may well be due to the retention of gastric

¹ Amer Jour Roentgenology, May, 1924

contents and secretions in the pocket. The treatment of such conditions should of course be surgical especially as the continued irritation from retention in such pockets may justly be considered a potential precursor of cancer.

The fact however that pulsion diverticula of the stomach have thus far been found near the cardiac orifice on the lesser curvature makes surgical treatment impractical and usually impossible because of the difficulty in mobilizing the stomach and dissecting the sac.

Occasional cases of so called traction diverticula of the stomach have been observed in various areas of the stomach. Probably these are simply penetrating ulcers with perigastritis in the inflammatory or the cicatricial stage.

DIVERTICULA OF THE SMALL INTESTINE (EXCLUSIVE OF MECKEL'S)

From the autopsy data the x ray data collected since 1912 together with the still scanty operative findings it would seem that duodenal diverticula stand second in frequency to those of the esophagus and are more frequent than those of the stomach.

Duodenal diverticula may be single or multiple. x Ray findings as in Case 3 collection of diverticula¹ show an incidence of about 6 per cent. multiple pockets in the duodenum jejunum and ileum but because of the fact that such lesions in the more distal portions of the small intestine are exceedingly difficult of demonstration the actual incidence of multiple diverticula is probably much higher.

The second portion of the duodenum is the part in which pockets are most frequently found though they are occasionally seen in the first part close to the pylorus as well as in the third and fourth parts. The size of the pocket varies greatly from the size of a pea to that of an orange. The presence of the diverticulum frequently has no effect upon the caliber of the adjacent intestine though this is occasionally constricted from pressure or greatly dilated.

The pathogenesis of duodenal diverticula, like that of those in other parts of the alimentary tract, is hypothetic. The classification of traction and pulsion diverticula is made here as in those of the esophagus. The traction pockets are produced by inflammatory processes in the neighboring organs, and as



Fig 248—x Ray and diagram of x ray showing duodenal ulcer with diverticular process due to periduodenitis. Pocket designated in diagram.

such processes occur frequently in the organs adjoining the duodenum, the gall-bladder, pancreas, and liver, traction sacs are usually found on the first and upper part of the second portion associated with gall-bladder disease. Penetrating ulcers frequently resemble such pockets, as in the case illustrated in

Fig 248 Pulsion diverticula are probably due to an inherent weakness in the intestinal wall and this plus the presence of some obstacle which has lodged in the duodenum or of stagnation of biliary and pancreatic juices produces a distention and finally a pocket. Occasionally the pathologic reports of such diverticula show the presence of pancreatic cells which would seem to indicate a congenital deformity causing no symptoms until distention from contents and pressure result or until stagnation and inflammation occur.

The structure of the diverticulum is usually that of the normal intestine with or without serous coat according to its location. Where considerable distention has occurred the muscularis is thinned out and absent in places and if the sac is very large the mucosa is likewise thin. Depending upon the location of the pocket the adjacent structures are or are not involved in the pocket. Biliary and pancreatic drainage may be disturbed by the obstruction of the common or pancreatic ducts through their enclosure in the diverticulum. They have been found to empty into the diverticulum. With diverticulitis, peridiverticulitis and involvement of the pancreas hemorrhagic pancreatitis and fat necrosis may result.

The diagnosis of duodenal diverticula is impossible clinically because the symptoms arising from inflammatory processes in the diverticula or from obstruction due to distention of the diverticula and pressure upon the adjacent duodenum, biliary or pancreatic organs simulate those arising from similar processes in those organs themselves. Epigastric distress, vomiting, sub-sternal pain, heartburn, constipation alternating with diarrhea, loss of appetite and weight, tarry stools and colicky pain in the right upper quadrant are seen in this condition and are frequently ascribed to other lesions of the right upper quadrant. The severity of the symptoms depends upon the degree of distention in the sac which in turn causes pressure on the duodenum just as the esophageal diverticula press upon the esophagus and cause obstruction. One case seen in the clinic has periodic attacks of colic resembling gall stone colic induced by ingestion of coarse food. Raisins particularly cause severe pain.

The x ray diagnosis of duodenal diverticula may be made with little difficulty if certain points are observed in technic. With the patient lying on his right side the angle between duodenum and jejunum is compressed and the barium held within the duodenum so that all possible pockets may be filled out and exposed. Previous examination should be made, first, to make certain that there are no other shadows present, such as those of gall stones or calcified lymph nodes, second to make certain the patency of the duodenum, as retention within the duodenum from any cause obscures the picture and makes it impossible to identify a diverticulum. If no other shadows are present in the preliminary examination and if barium passes normally through the duodenum the diagnosis of diverticulum rests upon a juxtaduodenal shadow which persists, which can be moved by the palpating hand, and which is not tender to palpation (unless as in an occasional case, peridiverticulitis is present). Such a shadow persists for six hours to forty eight hours after the meal as a definitely rounded shadow attached to but placed to one side of the intestine. Frequently, as in a case observed in the clinic and illustrated in Fig 249, a fluid level may be demonstrated. It is always necessary to differentiate in x ray diagnosis between an ulcer with a niche, a constriction of the duodenum due to local spasm and dilatation of the ampulla of Vater. Repeated fluoroscopic examinations may be necessary with the use of atropin to release spasm and confirm the diagnosis.

With the diagnosis of duodenal diverticulum made by x ray in a case suffering from gastro-intestinal symptoms otherwise unexplained, the treatment is distinctly surgical. In these cases, as in the esophageal diverticulum, the location of the sac is the important factor in the decision as to whether surgery is possible, but in the duodenal diverticulum this can be decided only by exploration. Dissection and resection of the sac are the operative procedures necessary for cure but the crux of the operation is the dissection. If the sac is found to lie dorsal to the head of the pancreas or to be involved in a mass of pancreatic tissue with pancreatic and biliary ducts included in the mass, dissection of the sac is exceedingly difficult and frequently im-



possible. When once the diverticulum is successfully freed from the adjacent structures, it should be resected. Invagination, as reported in a few cases, is much less satisfactory. Gastro-enterostomy is a desirable additional procedure, inasmuch as it gives temporary rest to the duodenum. Occasionally where a peridiverticulitis has been present, it becomes necessary to drain an abscess or to drain the gall-bladder or common duct. One case has been reported in which an ulcer and diverticulum were found in the same duodenum and the whole area was invaginated and a gastro-enterostomy done, but without permanent relief of symptoms.

The contents of the sac may be food, as in the case illustrated in Fig. 249, and operated in the clinic, where part of a motor meal given forty-eight hours before operation was recovered, or barium or chymous material, without recognizable food form, or, as in two reported cases, gall-stones.

The typical appearance of the sac on section is that of normal intestine, except in the most widely distended area, where muscularis and often mucosa is thinned out or lacking. There may be inflammatory changes, but in most cases these are not present.

If on exploration no surgery is possible, medical treatment in the form of non-irritating diet and care to maintain normal intestinal function are necessary, and, as in one case observed by us, where surgery has been refused, such treatment has been effective over a period of many years.

CHRONIC DIVERTICULA

In the past twelve years diverticula of the large bowel, which since Virchow's findings in 1853 were recognized by various observers from autopsy findings, and later recognized by Mayo and Moynihan surgically, have been demonstrated with increasing frequency by x-ray. Judd and Pollock report that one-third of the colons showing pathology have diverticulitis or diverticula.

These pouches may occur at any place from cecum to rectum, are usually single in other parts of the colon and multiple in the

sigmoid They are like diverticula of the rest of the alimentary tract at first true diverticula with all coats of the intestinal wall but with distention and inflammatory changes the muscularis becomes thinned and disappears in places In the sigmoid they are more prone to inflammatory changes than in any other part of the alimentary tube and with such changes fibrous tissue accumulates in the colon itself and in the surrounding tissue Within the sac itself the muscle and mucous membrane coats become thinned and rupture is more prone to occur than in diverticula located elsewhere The resulting condition according to Judd and Pollock's statistics is never a general peritonitis but always a localized abscess and this occurs in their series in about 9 per cent of operated cases Another extradiverticular condition recognized by Wilson is the peridiverticulitis seen with sigmoid diverticula with infiltration of mesenteric fat and symptoms from peritoneal irritation resembling a left sided appendicitis

The symptoms of colonic diverticula when inflammatory changes occur and cause symptoms are pain tenderness and constipation It is stated that about one-third of the cases have a palpable tumor in which cases a differential diagnosis between diverticulitis and carcinoma is difficult Diverticula with and without chronic inflammatory changes occur without symptoms and in this group of diverticula as in the gastric and upper intestinal group it is sometimes difficult to associate definitely and accurately the presence of the abnormality with symptoms of pathology Obstruction as a sign of diverticulum occurs usually only in the presence of inflammatory changes which produce a mass which in turn causes pressure upon or angulation of the intestine The pockets themselves in the colon are usually of such small size that even when filled with fecal material they are not obstructive Examples of such pockets are seen in the case illustrated in Fig 250

The diagnosis of colonic diverticula by x ray is less constant than in diverticula of the upper gastro-intestinal tract The contents of the colon being of firmer consistency than those of the stomach and small intestine may easily fill the pockets so

tightly that no barium enters. When inflammatory changes have occurred, a spastic sigmoid with a thickened wall and possible obstruction point toward diverticulitis. Diverticula diagnosed by x-ray should be differentiated from kinked areas of intestine filled with barium, ureteral or bladder calculi, or calcified mesenteric lymph nodes.



Fig. 250—Showing diverticula of sigmoid in a case of diverticulitis

Diverticula of the colon, because they are in themselves non-obstructive, need no treatment. When inflammatory changes have occurred and are sufficiently severe to cause pain, tenderness, constipation, or obstruction, it becomes necessary to decide between medical management and surgery. If a palpable mass is present, even without blood in the stools, it is almost necessary to explore unless there has been a long-standing history of

similar symptoms with remissions in which case it is fair to assume that the condition is diverticulitis. Even with exploration it is sometimes impossible to determine without a histologic examination whether the condition is simple diverticulitis or carcinoma. The ideal surgical procedure is resection but unfortunately since this procedure must be executed in the presence of infected bowel wall its mortality is exceedingly high. Palliative surgery consists in colostomy but this in no way causes the existing diverticula to disappear but allows the inflammatory process to subside only as long as the fecal current is diverted and the same possibilities of complications persist if the fecal stream be restored to its normal course. The actual surgery of diverticulitis therefore consists largely in palliative measures such as drainage of perisigmoid abscesses colostomy for obstruction resection when the suspicion of malignancy is sufficiently grave or when the localization of the process makes the prognosis seem sufficiently favorable. Occasionally also rectovesical sinuses due to rupture of infected diverticula into the bladder require repair. Even in this relatively minor condition recurrence however is not uncommon. It is evident therefore that the surgical treatment of diverticulitis of the colon is by no means entirely satisfactory and consists largely of dealing with problems secondary to this condition as they arise. Medical management is frequently adequate in that normal bowel function and relief of colonic spasm empty the pockets remove the irritating cause of the inflammatory process which then frequently subsides. The recent treatment with barium enemata though apparently successful in some cases appears illogical from the point of view of etiology of the condition in that a pocket already partly filled with feces if still further occluded with barium holds the original source of irritation even longer than usual. Only pockets which were by chance empty before injection of the barium are protected from the irritation of feces.

It is now believed that diverticulitis is not at all a precursor of carcinoma.

CONCLUSIONS

From a consideration of diverticula of the various parts of the alimentary tube it may be concluded that the symptoms of diverticula arise from the same causes in all parts of the tube, namely, from retention of tube contents and pressure of the filled sac or from inflammation. Symptoms from pressure of the uninflamed sac occur more frequently in the esophagus and with decreasing frequency in the lower parts of the alimentary tube. Inflammatory changes occur with greatest frequency in the lowest end of the gastro intestinal tract because of the irritation of the dehydrated contents. The only cure of diverticula is resection, but in all parts of the gastro intestinal tract this is frequently impractical because of the inaccessible site of the sac. Medical treatment consists chiefly in the establishment or maintenance of normal function of the gastro intestinal tract in order that the pockets may be kept empty or in the dilatation of strictures caused by pressure in the part accessible to such treatment.



END-RESULTS—CLINICAL, CHEMICAL, AND MECHANICAL—IN TWELVE PYLORECTOMIES

SARA M. JORDAN

IN the treatment of gastric and duodenal ulcers the choice of medical or surgical treatment is the first consideration. Where there are no definite surgical indications, such as (1) the acute condition due to perforation, or (2) an unrelievable obstruction, or (3) a reasonable ground for suspicion of carcinoma, medical management should, in our opinion, be used first. In those cases where *medical management fails*, and this occurs in certain chronic ulcerations where a bleeding vessel protrudes from the center of a callous area, and in those cases which, when first diagnosed, have distinctly surgical indications, there arises at once the consideration of a choice between conservative and radical gastric surgery. The position of conservative surgery, gastro-enterostomy with or without excision of ulcer, according to recent reports in the literature, is at least uncertain at the present. The frequency of jejunal, gastrojejunal, and recurrent duodenal ulcers has tended to make doubtful the position of this more conservative form of surgery. Better functional results follow the more radical forms of pyloric and gastric resection. Of course in those cases in which there is a suspicion of carcinoma or where conservative measures in the form of medical management have been adequately tried and failed, the definite surgical risk may be fairly undertaken.

To the removal of the acid generating part of the stomach is ascribed the reason for better functional results. In other words, it is believed that with the partial or complete surgical removal of the corrosive factor in ulcer formation, new ulcer formation is prevented. Stein and Fried in 1923 reported observations which showed that anacidity and hypochylia, the usual result

of extensive stomach resections were gradually produced with a slower decrease in the ferment content than in the acid. Directly after operation there was a tremendous secretion of gastric juice probably due to stimulation from the cut secretory fibers. The fasting contents showed a much higher acidity than those obtained after a test breakfast a fact which was explained by these investigators as due to the increased stimulation caused by the injured centripetal nerves as contrasted with a lack of stimulation from the contact of food with the mucous membrane of the antrum. After two months subsequent to the operation the secretion after the test meal contains more free acid than that of the fasting contents.

Ivy and Yutaka Oyama showed in 1921 that Beasley's conclusion that the secretion of the pyloric gland is purely mucous and contains no specific digestive substance is correct. The removal of the antrum of the stomach is therefore necessary to produce a depression of the digestive secretions desirable because of the presence in them of acid with its corrosive action. The untoward concomitant symptoms of unexplained functional anacidity, gas distress and diarrhea have not been observed by us in postoperative cases with anacidity. Stein and Fried carried on certain investigations to demonstrate that with the surgical depression of hydrochloric acid there is a compensatory pancreatic hyperchylia.

It is therefore probable that the chemical loss resultant upon subtotal gastrectomy, however extensive this may be, is desirable from the point of view of prevention of ulcer recurrence and probably because of pancreatic compensation is not detrimental to digestion.

What is the effect of resection on the mechanical function of the stomach? That normal tonus and peristalsis are extremely important factors in gastric comfort is a well known fact. Hypermotility and excessive tonus are the familiar cause of distress especially in the ulcer picture. The opposite defect, namely gastric atony and a failure of the stomach or remnant of stomach to hold and to peristalt its contents are too infrequently considered as of importance in a failure to secure postoperative

comfort In our observation a portion of stomach, however small it may be, which whether because of its unimpaired or restored innervation or for some other reason, holds for a time the material which enters it by the muscular tonus of its walls and moves it along at a normal rate, and with rhythm gives to its possessor a sense of gastric comfort and well being comparable to that secured by the function of the normal stomach.



Fig. 251—Showing pylorectomy case one year after operation Good function Normal tonus Emptying in three hours

On the other hand, the remnant of the stomach, which looks and, what is more important, acts like a funnel or sand screen, empties rapidly into the jejunum and causes discomfort which may be a mild sense of fulness after food taking or may be so severe as to cause nausea, vomiting, emaciation, and chronic invalidism.

It should be the aim of surgery in both the obviously malignant as well as the benign lesions to obtain mechanical efficiency

of the remaining portion of the stomach as well as the safe removal of the pathologic part and the prevention of ulcer recurrence by surgical depression of acid

The method for accomplishing this end will be clear only with the aid of continued study on the part of the surgeon clinician, and laboratory workers



Fig 252 —Pylorectomy case three years after operation Muscle tonus of stomach wall poor Function poor Rapid emptying into jejunum Clinical condition poor Ten months after this observation this patient was found to have recurrent carcinoma at the stoma

The table on p 771 demonstrates briefly the clinical, chemical, and mechanical results in twelve pylorectomies done in this clinic, which were available for follow up observations

Unfortunately only Cases I II and III had preoperative gastric analyses which were as follows

Case I—28-44

Case II—10 24

Case III—0 9

TABLE SHOWING END RESULTS—CLINICAL, CHEMICAL AND MECHANICAL—IN TWELVE PYLORECTOMIES

Case number	Type of operation	Year of operation	Diagnosis	Symptoms 1925	Free and total acidity, 1925	Mechanical function observed fluoroscopically	Emp
1 A I	Polya type of pylorotomy	Nov. 1923	Carcinoma of antrum	None	0 20	Tonus good	Emp
2 H R	Polya type of pylorotomy	June, 1924	Lymphoma with ulceration	None	0 6	Peristalsis normal	Emp
3 W G	Polya type of pylorotomy	August 1924	Chronic ulcer	None	0 4	Peristalsis normal	Emp
4 I R	Polya type of pylorotomy	January 1923	Chronic ulcer	None	6-18	Tonus good	Emp
5 A A	Hillroth No. 2 pylorotomy	January 1922	Chronic ulcer	None	21 35	Peristalsis normal	Emp
6 F C	Polya type of pylorotomy	1923	Chronic ulcer	None	51-65	Peristalsis normal	Emp
7 P M	Polya type of pylorotomy	1922	Chronic ulcer	None	29 46	Tonus good	Emp
8 B A	Polya type of pylorotomy	1922	Chronic ulcer	Slight gas distress after food taking	22 38	Peristalsis normal	Emp
9 B L	Polya type of pylorotomy	1921	Carcinoma of antrum	Gas distress after food taking relieved by bowel management	0-12	Peristalsis normal	Emp
10 M R	Polya type of pylorotomy	1923	Carcinoma of antrum	Severe nausea and abdominal distress after food taking. Loss of weight	No contents recovered thirty minutes after test meal	Peristalsis normal	Emp
11 D H	Hillroth No. 2 pylorotomy	1923	Chronic ulcer	Gas distress after food taking	0 3	Peristalsis normal	Emp
12 B P	Polya type of pylorotomy	1922	Chronic ulcer	Ulcer distress due to recurrent gastric ulcer. Relieved by medical management	21-40	Peristalsis normal	Emp



Fig. 253 —Pylorectomy case three years after operation, showing acute recurrent ulcer at the stoma



Fig. 254 —Same case after medical treatment of ulcer Stoma smooth.

The striking fact in the follow-up observations of this small series is that though the chemical findings vary from an anacidity in 4 cases and a subacidity (free HCl-6) in one case to normal acidity (free HCl-21 to 29) in 3 cases, and a free HCl of 51 in 1 case, the presence or absence of acid apparently bears no relation to the clinical condition, whereas the mechanical function, as observed fluoroscopically, was normal in 7 out of the 8 cases who had no symptoms (Cases I to VII and IX). Emptying time in these 7 cases was two to three hours. Case IV had no fluoroscopic examination. In Cases VIII, X, and XI, who had symptoms, the mechanical function was observed to be poor and the emptying time one hour or less. Case X was the only case suffering from severe symptoms with resultant malnutrition. Her mechanical function was poorest, and ten months after this follow-up examination this patient was found to have an inoperable carcinoma at the stoma. Case XII showed recurrent ulcer at the stoma which disappeared clinically and by radiologic examinations under medical management.

Numerous observations made after gastro-enterostomy also show the importance of the maintenance of tonus and peristalsis as the chief factor in postoperative comfort. Anacidity is rarely produced in our experience by gastro-enterostomy, and the presence or absence of acid, however important it may be in the question of incidence of gastrojejunal ulcer, bears apparently no relation to postoperative comfort. Here again, however, the preservation of gastric tonus and peristalsis are coincident with a lack of distress, whereas the dumping type of stomach with rapid filling of the jejunal loops is a source of constant distress to its possessor.

CONCLUSIONS

The tendency in recent treatment of gastric and duodenal ulcers seems to be both more conservative and more radical, more conservative, in that medical management in a well-regulated and adequate form is used as long as it is fair—more radical in that when surgery is used, the conservative form of gastro-enterostomy tends to be supplanted by radical resection of the acid and ulcer-bearing area of the stomach. It is, there-

fore opportune to consider end results of both methods of treatment and to direct our efforts toward securing postoperative comfort in the more radical form of treatment, when it is employed

BIBLIOGRAPHY

- Stein and Fried. Wiener Klin Wochenschrift 1923 No 44 pp 775-777
Ivy and Yutaka Oyama. Amer Jour of Physiol 57 1921 pp 51-60

SUBPHRENIC INFECTION AFTER APPENDICITIS

HOWARD M. CLUTE

THE patient before us is a young man of twenty two. He was born with deformities of all of his limbs which have necessitated a long series of orthopedic operations. As a result of these procedures he has been able to get about on crutches and to do many things for himself with his hands and arms. Aside from these deformities and the illnesses accompanying their operative repair he has had nothing remarkable in his past medical history.

Forty eight hours before entrance to the hospital this boy was taken with a severe pain in the central portion of his abdomen. The pain gradually became localized in the lower right quadrant. He vomited. Castor oil was given him at home, which caused a bowel movement, but gave no relief from his pain. He therefore took some other cathartic. Because this also failed to relieve the pain and because he was still vomiting he was brought to the hospital on February 11, 1926.

The notable findings on physical examination were the abdominal distention and generalized muscle spasm. Tenderness was present everywhere across the lower third of the abdomen, but was more pronounced on the right side. Rectal examination revealed tenderness, but no swelling. His chest showed no evidence of pathology. His urine showed the slightest trace of albumin. 3 to 6 white blood cells and a rare red blood cell in each high power field. His white blood count on admission was 26,450. His temperature was 101.2° F., his pulse 120 and respirations 26.

A preoperative diagnosis of perforating appendicitis with beginning peritonitis was made, and he was taken at once to the

operating room. At operation it was found that the appendix lay to the outer side of the cecum and was gangrenous in its proximal portion. There was a perforation just at the junction of the cecum and appendix from which fecal matter was exuding. The incision was enlarged, anesthesia deepened to secure adequate muscular relaxation and the infected area very carefully walled off with wet gauze strips. Under direct vision the appendix was readily removed and cigarette drainage inserted to the point at which it had rested. The omentum was gently tucked in around the drain and the cecum. The abdomen was closed in layers about the cigarette drain.

After operation the condition of the patient improved. He was elevated on a head rest and in addition the head of the bed was also raised on blocks. Because of the patient's many deformities and his inability to flex his thighs it was rather difficult to keep him in a high Fowler position. For the first forty-eight hours he was given absolutely nothing by mouth. Morphine was administered in sufficient quantities to keep him completely quiet. Tap water was given by rectum every four hours and an intravenous injection of 500 c c. of a 10 per cent solution of glucose was given twice daily. After forty-eight hours of this regime water was given by mouth and was soon followed by other liquids and soft solids.

In four or five days it became apparent that the danger of peritonitis and death in this case was passing. The abdomen became soft, gas was passed readily by rectum and food and fluids were well retained. His general appearance improved very markedly. The fever which was present before operation however did not disappear. As the days grew in number and as his condition improved otherwise it was expected that his temperature would come to normal. Instead however, it remained constantly elevated at a level between 101° and 102°. There were no subjective symptoms offering a clue possible cause of the persistent fever.

It has been our experience that persisting fever after laparotomy is almost always due to one of three causes: (1) the wound, (2) the pouch of Douglas or

etiology for a subphrenic abscess was present (2) No focus of infection either in the wound or the pouch of Douglas could be found (3) The patient had no symptoms save persisting fever and rapidly increasing weakness



Fig. 255—This x ray shows density in the right chest except at the apex with evidences of fluid or thickened pleura at the base. The heart is pushed to the left. Chest tap after this picture gave only clear serous fluid. This illustration has been reversed in reproduction.

A portable x ray of the chest was taken on February 23d by Dr. L. B. Morrison who reported as follows (Fig. 255). The right chest is completely dense except the very apex. The diaphragm is not seen. The heart is pushed somewhat to the left. The left chest is otherwise normal. We should

judge there was fluid in the right chest with thickened pleura "

The chest was tapped, and clear serous non infected fluid was withdrawn. A needle was then inserted in the tenth inter space in the right midaxillary line and pushed inward beneath



Fig. 256—Plate taken after withdrawal of much serous fluid from the chest. Heart is still pushed to the left. Level of diaphragm on the right is not apparent. It was probable however that pus was present beneath the diaphragm in view of the fever and the sterile fluid in the chest.

the diaphragm in an attempt to find pus above the liver. None could be found. It was our opinion however that the pus was in that location. It is almost always true that a simple serous pleurisy will be present in the chest when there is pus just beneath the diaphragm. The amount will vary from a few to

several hundred cubic centimeters. Since this patient now had serous fluid in his right chest which had been clear before his operation we inferred that it was in some way related to his present difficulties though obviously the chest fluid was not the cause of the fever. It seemed increasingly evident that there was pus beneath the diaphragm and above the liver on the right side if we could but find it.

After an interval of eight days the patient's fever was still high and his general condition seemed distinctly poorer. A further search for the subphrenic pus was undertaken. His chest was again aspirated and all the fluid possible was removed. The needle was again inserted at a lower level beneath the diaphragm into the subphrenic space. Clear serous fluid came from the pleural cavity. Nothing was found beneath the diaphragm. An x ray after this procedure showed the right chest about half filled with fluid. No air noted under the diaphragm on this side. The heart is slightly pushed to the left.

Two days later another puncture was made in the posterior axillary line in the tenth right space into the subphrenic space. Much foul smelling pus was obtained and the long search for the cause of the fever was rewarded. On the same day March 8th almost a month after the appendectomy the patient was again taken to the operating room and under local anesthesia the first stage of the operation which we prefer for draining a subphrenic abscess was performed. Two inches of the tenth rib were removed in the posterior axillary line at the site of the puncture which had returned pus. The pleural cavity was opened and the parietal layer of pleura was sutured to the diaphragm with a running stitch. This is readily performed because the abscess beneath the diaphragm pushes it up to an abnormally high level and thus brings its lateral portion in relation with the lateral wall of the chest. The running suture may fully wall off the pleural cavity but we prefer to pack the wound and wait for forty eight hours until fairly firm adhesions have formed before we open the abscess. Failure to observe this precaution may result in empyema. After two days therefore we performed the second stage of the operation. The

patient was given ethylene and oxygen anesthesia and the pack removed from the incision. The fibers of the diaphragm were now incised and retracted. Just beneath them could be seen the liver. A finger gently inserted encountered dense adhesions posteriorly between the liver and the diaphragm. These were



Fig. 257.—Later view of the right diaphragm showing a finger inserted into which has been inserted to drain the subphrenic abscess. The tube lies just beneath the diaphragm and above the liver. The adhesions between the diaphragm and the liver are now rapidly receding.

gently freed, a big abscess cavity was entered, and a large quantity of foul smelling pus evacuated. A cigarette drain and a rubber tube were inserted and a few skin sutures put in place.

It is now eight days since the abscess was drained. But little pus comes from the wound and the drains are being replaced with rubber tissue. The temperature has gone to a lower height

each day and today has been scarcely above normal. The patient's general appearance and sense of well being are rapidly improving. Recovery now seems assured.

A recent lateral x ray of the chest (Fig. 257) shows the right diaphragm is still much higher than normal. The drainage tube can be seen just beneath it. The evidences of pathology above the diaphragm are rapidly disappearing in the x ray picture.

CONGENITAL DEFECTS OF THE KIDNEY

HOWARD M. CLUTE

DEVELOPMENTAL disturbances of the kidneys and ureters are classified as defects in (1) number, (2) form, and (3) position. The following 4 case histories give examples of each of these possible difficulties.

The developmental changes bringing about the normal adult position and function of the kidneys and ureters are extremely complex and are completely interwoven with the development of the reproductive organs. As would be expected, therefore, congenital defects of the kidneys or ureters are not infrequently associated with defective development of the internal or external reproductive organs. At about the fourth week of embryonic life a bud appears near the cloaca on each Wolffian duct from which develops the ureter, kidney pelvis, and later the kidney. This original point from which the urinary apparatus grows is situated in the true pelvis at about the level of the second sacral vertebra. At this level the kidneys slowly develop and also gradually migrate upward to their normal adult position. During this migration from the pelvis there occurs an axial rotation of the kidney. The pelvis, which in the original position of the kidney is ventral, gradually rotates inward to assume its mesial direction. The blood supply of the kidneys does not become finally established until the kidney has reached its permanent position. During its early growth and migration the vascular supply of the kidney is by means of numerous capillary vessels. When the kidneys are finally placed in the loins suitable capillaries enlarge and become the renal vessels. All the abnormalities of number, form, and position of the kidneys can be readily explained and understood with a knowledge of the factors involved in the development of the urinary tract.

Case I—B K, a woman aged twenty-four, came first to the clinic in November, 1924 because of pain in the left back radiating down the left loin. She had never had any previous illness of note and had always considered herself healthy.

For the past four or five months this woman had had nearly constant backache. During the past four days the pain has been very severe. General examination was negative save for tenderness over the left kidney. The urine was normal. Wassermann negative. NPN normal. Phenolphthalein excretion normal. Cystoscopy showed a good function and normal urine on the

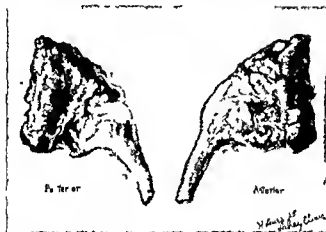


Fig. 728—Case I. Drawing of specimen of rudimentary kidney removed in Case I. Note normal appearance of pelvis and ureter. Maldevelopment largely limited to structures of the cortex.

right. On the left side was diminished function but clear urine. Pyelo ureterograms showed an infantile kidney on the left with a very narrow strictured ureter and a normal kidney on the right. It was found that the passage of ureteral catheters relieved the left kidney pain and an attempt was made to carry this patient along with occasional ureteral dilatation. For a time this succeeded, but in June 1925 dilatation was found to be insufficient and the infantile kidney was therefore removed. Recovery since operation has been uneventful.

Congenital absence of one kidney is very rare. From a

careful survey of many autopsy records Morris states that this abnormality occurs about once in 2500 cases. In some cases no vestige of the absent kidney is found. In other cases, as in the present instance, development has gone on to a certain degree and then ceased. This type of kidney is termed by some writers a "congenitally atrophic kidney."

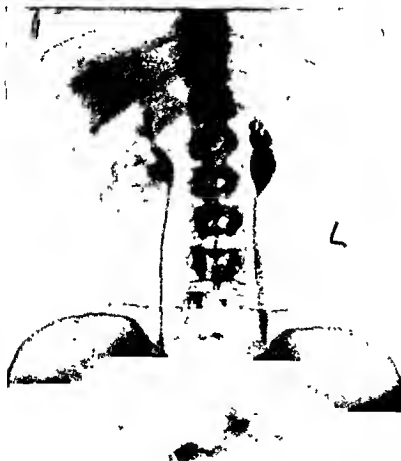


Fig. 259—Case I. Bilateral pyelogram showing rudimentary kidney on the left and normal kidney on the right.

Rudimentary kidneys may be found in any stage of development and of function. In the present case clear watery urine was secreted, as well as a small amount of phenolsulphonaphthalein. Pyelo-ureterograms were made showing the contour present (Fig. 259).

The reason for the repeated attacks of left renal colic with frequent and painful urination which this girl suffered is not clear. There was never any evidence of infection in either the urine examinations or the cystoscopic picture. No further pain has occurred since the operation.

Case II.—Mr F. C F., a man aged forty-two, came to the clinic August 12, 1925 because of pain in the left lower quadrant.



Fig. 260.—Case II Plain x-ray plate of abdomen showing outline of horseshoe kidney.

In the course of his examination cystoscopy was done and pyelograms were made which revealed a horseshoe kidney at the level of the second lumbar vertebra. The pelvis on each side

was normal, as was the ureter. The urine from each side was normal. The pain in the left abdomen was found to be due to enlarged mesenteric nodes and not related to the horseshoe kidney. No operation was necessary and all symptoms have now disappeared.

Horseshoe kidneys are not uncommon. They occur, on an average, once in 1100 people, and are examples of maldevelop-



Fig. 261—Case II. Bilateral pyelogram in case of horseshoe kidney. No pathology other than fusion of the cortex is noted, each pelvis being normal.

ment in the form of the kidneys. Horseshoe kidney is the result of a fusion of the lower poles of the kidneys before the third month of intra-uterine life. The resulting deformity of the kidneys depends on the degree of fusion, the limitation of the ascent of the kidneys by the deformity, and the absence of axial

rotation of the kidneys. The bridge of tissue connecting the two kidneys may be fibrous tissue or good renal tissue.

The two pelves of the horseshoe kidney illustrated here show no fusion, and we may infer that the cortical fusion occurred after the pelves were fully developed.

Horseshoe kidneys may cause no difficulty throughout the patient's life. Symptoms may appear, however, from the same causes that act in normally shaped kidneys, such as stones, ob-

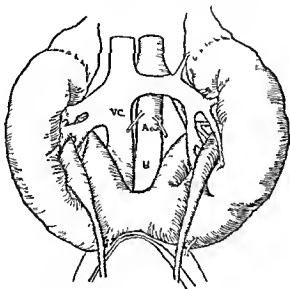


Fig. 262—Case II Schematic drawing of horseshoe kidney (Adapted from drawing in Kelly and Burnham's *Diseases of the Kidneys, Ureters, and Bladder*)

structions to the ureter, infections, and new growths. In the case presented here we were unable to find any abnormality in the horseshoe kidney or any symptoms referable to it.

Case III.—C. W., a single woman, aged twenty-seven, came to the Clinic August 11, 1925 complaining of attacks of pain in the left side and back with fever and vomiting.

Three years ago this patient had been operated upon in another city. At that time an incision was made over her right

kidney region. No kidney was found. A second incision was made over the gall-bladder, and further search revealed no evidence of a kidney on the right. The gall-bladder was drained and the appendix removed.



Fig. 263—Case III. Large stone in pelvis of left kidney. Pyelogram of pelvic kidney on the right. Note the calices above the bladder which is partly filled with sodium iodid. The remains of a barium enema are still visible in the rectum.

During the past three years since this operation the patient has had repeated attacks of severe pain in the left flank. These were accompanied by severe constipation and disappeared with repeated enemata. The present attack was more severe than any she had previously experienced. There was no painful or frequent urination. Examination showed a thin, pale woman.

General examination was negative save for tenderness over the left costovertebral angle with heavy (fist) percussion. The urine showed a slight trace of albumin and much pus, with rare red cells. The NPN was 30 mgm per 100 c.c. The total phenolphthalein excretion at the end of two hours was 48 per cent. x-Rays of the gastro-intestinal tract revealed no lesion associated

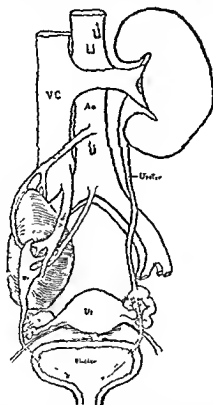


Fig. 264—Case III. Schematic drawing of pelvic kidney (Adapted from Kelly and Burnham's *Diseases of the Kidneys, Ureters, and Bladder*)

with the bowel. x-Rays of the urinary tract showed a stone in the left kidney pelvis which was nearly a complete cast of the pelvis. No kidney outline could be seen on the right. Cystoscopy showed a bladder not abnormal in appearance. The left ureteral orifice was gaping and somewhat red. On the right side a normal ureteral orifice was found. After catheterization urine

was obtained from each ureter. On the right it was clear and on the left it showed pus and blood. The phenolphthalein test appeared in four minutes on the left side and five minutes on the right, and was of excellent color on each side. x Rays showed the catheter in the left ureter in relation to the stone in the left pelvis. A pyelogram on the right side showed a pelvic kidney smaller in size than normal. In this ureter near the pelvis was a stone.

At operation the large cast of the left kidney was removed through an incision in the pelvis extending upward into the cortex of the kidney. Recovery from this operation has been complete.

Case IV—E. T., a woman married, aged forty seven, came first to the Clinic August 31, 1925 complaining of painful micturition. She had never been ill since childhood and had never been pregnant. She stated that four weeks ago she had had fever, chills and frequency of urination. At this time she also had some tenderness over her left kidney region. Her urine showed pus. She has had occasional attacks of fever during the past month.

Examination showed nothing remarkable, save for some tenderness in the left loin. The urine showed pus cells and an output of 38 per cent phenolphthalein. The NPN was normal. Cystoscopy showed nothing remarkable in the bladder. The left ureteral orifice was somewhat edematous. The right ureter appeared normal. A catheter passed readily to the left kidney, but no catheter could be passed more than 2 inches on the right side. Urine from the left kidney showed a few pus-cells per field. No urine came from the right side. Pyelograms were made. On the left side was found a kink of the ureter at the ureteropelvic junction with early blunting of the calices and dilatation of the kidney pelvis. On the right side, after several attempts and the use of considerable pressure, the injecting fluid ran in but a short distance to a dilated area that was apparently the pelvis of a pelvic kidney. No kidney outline could be seen in the right flank and it was our opinion that this patient

had a pelvic kidney on the right which had little if any function. The left kidney was exposed through the lumbar route, and aberrant vessels distorting the ureter were removed and the kidney was suspended. Recovery was uneventful.

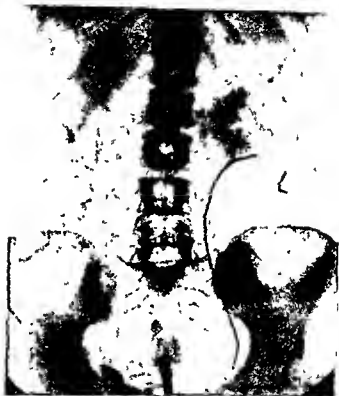


Fig. 265—Case IV. Pyelogram of right kidney showing it to be rudimentary and still present in the pelvis. Repeated plates show no evidence of any lumbar kidney on the right. The left kidney was normally located.

Defective kidney development resulting in abnormal position of the kidney is not often seen. These 2 cases are excellent examples of this condition. A kidney may be in an abnormal position as a result of an unusually loose attachment to its surrounding structures or as a result of the presence of pathology in the kidney or in a neighboring viscus acting upon it. We have seen a simple serous cyst in the lower pole of an otherwise

normal kidney pull the kidney well down to the brim of the true pelvis. In these cases, however, the ureter is of normal length and extends over a markedly distorted, tortuous course. When the kidney fails to rise to its normal position in embryonic life, the ureter is generally entirely pelvic and much shorter than in the normal kidney. In pelvic kidneys variations in form or number as well as in position may be present. The pelvic kidney, however, may be normal in every respect save its position.

Abnormalities of the generative organs are said to accompany all three types of developmental kidney defects. In these 4 cases no such abnormality is obvious, although in 2 of the cases only superficial examination has been made. In one of the patients having a pelvic kidney an infantile type of uterus is present and the patient has never been pregnant through many years of married life.

Pelvic kidneys have considerable clinical importance. This possibility must be considered when any retroperitoneal tumor is found in the pelvis. The presence of a pelvic kidney may cause marked difficulty in labor. Stones, ureteral obstructions, infections and tumors may also occur in pelvic kidneys. These may give rise to unusual symptoms because of the abnormal position of the kidney. In Case III, however, a stone in the ureter or pelvis of the kidney has apparently caused no symptoms.

